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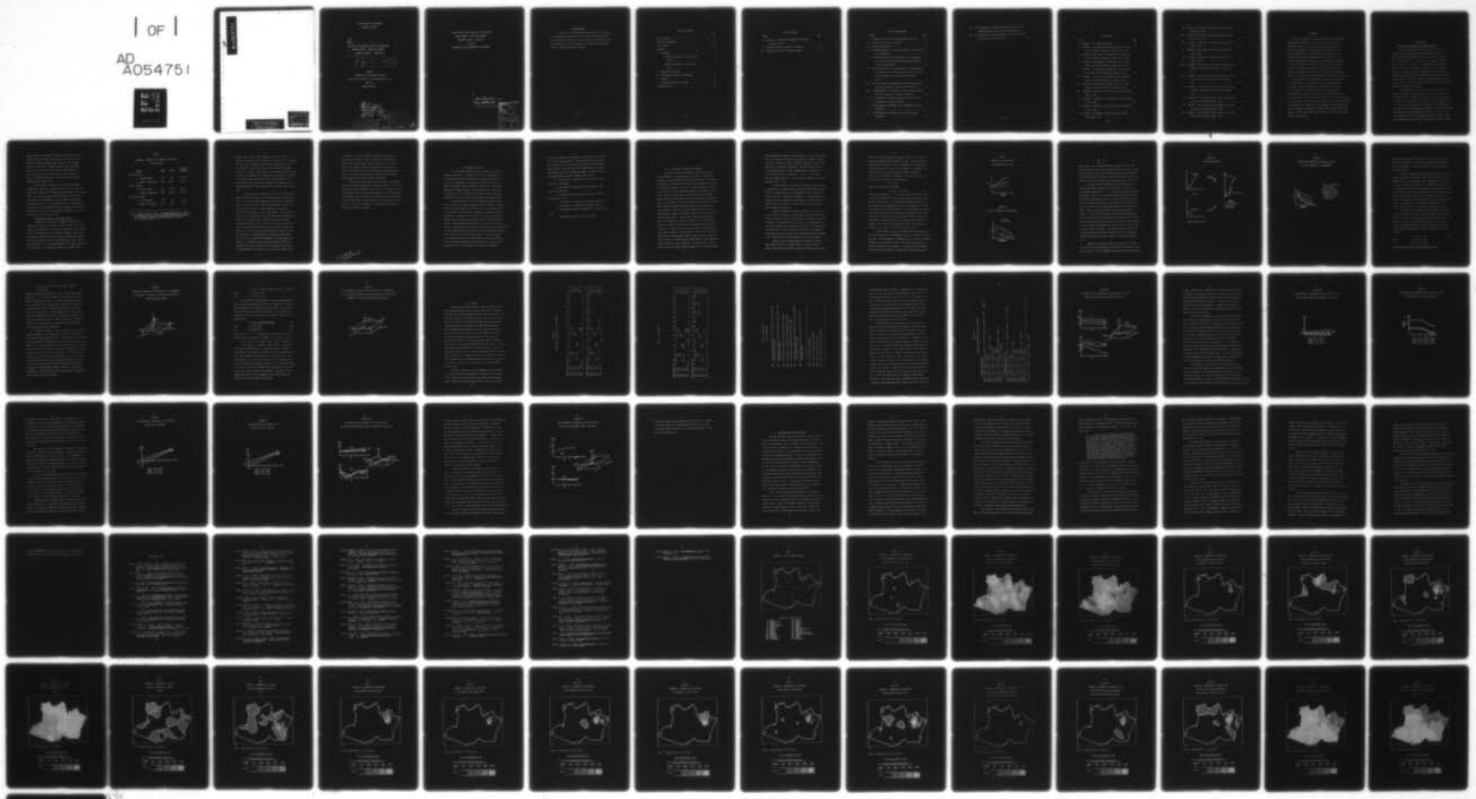

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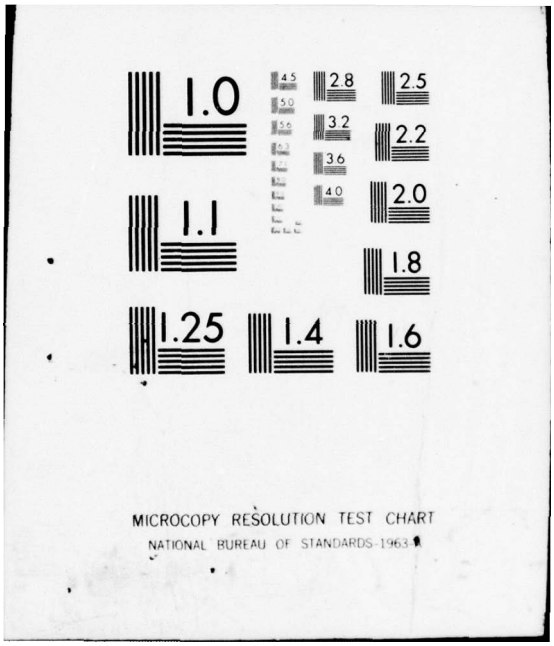
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A TEST OF THE SPATIAL ASPECTS OF A REGIONAL GROWTH CENTER: THE CASE OF MANAUS, AMAZONAS, BRAZIL 1950-1970.

(9) Master's Thesis,

A THESIS

SUBMITTED TO THE GRADUATE FACULTY

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degree of

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A TEST OF THE SPATIAL ASPECTS OF A REGIONAL GROWTH CENTER: THE CASE OF MANAUS, AMAZONAS, BRAZIL 1950-1970

A THESIS

APPROVED FOR THE DEPARTMENT OF GEOGRAPHY

By

R. L. Turner

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A. Hinton

ACKNOWLEDGMENTS

I would like to acknowledge Professor Billie L. Turner II for inspiring me to work in this field and providing direction. The completion of this effort could not have been realized without the technical advice and constructive criticisms of Professors Robert Q. Hanham and James R. Bohland.

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ABSTRACT

With the creation of the Amazonian Economic Development Superintendency (SPVEA) in 1953, Brazil sought to bring the Amazon Basin out of its forty year old economic decline that followed the collapse of the natural rubber industry in 1914. Brazilian regional development planning has made use of the "growth pole" concepts of Perroux in the formulation of its economic development strategies which culminated in the Program of National Integration of 1970. Recently a number of Latin American countries have abandoned the use of "growth pole" theories for planning on the basis of theoretical, ideological, political, and practical considerations. The purpose of this paper is to test some of the spatial aspects of economic development in Amazonas and to assess whether recent government-induced development centered on Manaus is spreading to the remainder of the region, or is merely strengthening pole-periphery differences. The results indicate that spread effects from Manaus have been local, if not non-existent, and that the size of the municipal population, not distance from Manaus, was the most significant determinant of the intensity of the surrogates. Development seems to be contingent on community size rather than spread effects from Manaus, a factor which should be considered in future developmental goals and strategies.

I. BACKGROUND

Historical Traditions in Growth Pole Theory

Perroux's concept (1955) of the "growth pole" has been popular with economic planners and geographers involved in regional economic development since its introduction 22 years ago. The maxim that ". . . growth does not appear everywhere at the same time. . . [but] . . . manifests itself in points or 'poles' of growth with variable intensities. . ." (Perroux, 1955) is a concept of inherent simplicity and logic (Gilbert, 1975) and has been modified by academicians such as Berry (1969), Hansen (1967), and Friedman (1966) to include geographic space (location) as well as the economic space (inter-industry linkages) originally inteneded by Perroux.

In geographic space, the concept of "growth poles" (or "growth centers") has been popular because it lends itself to hypotheses that tie together the analysis of regional growth and the analysis of the spatial structure of regional economic activity. The theory lends itself to treatment by many analytical techniques and has many possible applications to those in national and regional economic planning (Parr, 1973). In short, a host of literature has evolved concerning growth pole theory itself (Alonso and Medrich, 1972; Berry, 1973; Darwent, 1969; Friedmann,

1966; Gauthier, 1970; Hansen, 1967; Parr, 1973), its effects, "spillover" and "backwash" (Hirschmann, 1958; Hansen, 1975; Richardson, 1976; Richardson and Richardson, 1975; Thomas, 1972), its analytical treatment (Cassetti, King and Odland, 1971; Gaile, 1974; Hansen, 1975) and its effectiveness in specific regions (Berry, 1969; Gilbert, 1974; Katzman, 1975; King, 1974; Robinson and Salih, 1971; Semple, Gauthier and Youngman, 1972; Santos, 1975).

Recently growth center theory has been challenged on theoretical, ideological, political, practical, and social considerations (Conroy, 1973; Richardson and Richardson, 1975; Santos, 1975). By 1973 three Latin American countries (Chile, Bolivia, and Colombia) had abandoned its use in regional development planning (Conroy, 1973). As Berry points out, concentration of resources in urban development tends to increase rural-urban inequalities and leads to the development of primate cities, not the region as a whole (Berry, 1969).

Regional Development in the Amazon Basin

A comparison of measures of commerce and industry in Amazonas for 1960 and 1970 (TABLE I) give an idea of the rapid rates of commercial growth in Amazonas during that decade. This growth rate contrasts with the economic stagnation and decline in Amazonas during the forty year period following the collapse of the natural rubber boom in 1914 (Goodland and Irwin, 1975). The rising level of economic development in the Amazon Basin has been the subject of an extensive literature (Dalland, 1967;

TABLE I

AMAZONAS: COMPARISON OF COMMERCE AND INDUSTRY

IN 1960 AND 1970.

Sector	1960	1970	Percentage Change
Manufacturing:			
a. Establishments	313	587	+87.5%
b. Number of employees	4671	10,674	+128.5%
Retail Commerce:			
a. Establishments	2752	5643	+105.1%
b. Number of employees	6582	13,449	+104.3%
Wholesale Commerce:			
a. Establishments	527	414	-21.4%
b. Number of employees	2117	2487	+17.5%

Source: Brazil, Fundacao IBGE. VIII Recenseamento Geral - 1970. Serie Regional Vol. IV, Tomo III, Censo Industrial - Amazonas, and, Vol. VIII, Tomo III, Censo Comercial - Amazonas, Rio de Janiero, 1975.

Graham, 1970; Jameson, 1975; Katzman, 1975; Leff, 1968 and 1972; Merrick, 1976; Nelson, 1973; Resende, 1973; Robock, 1975; Rosenbaum and Tyler, 1972; Saunders, 1971; Tuthill, 1969; Wagley, 1971) even though it was treated as part of the economic development of Brazil as a whole. More recently, the academic world has begun to focus on development in the Amazon Basin specifically (Denevan, 1973; Foland, 1971; Goodland and Irwin, 1975; Katzman, 1975; Kleinpenning, 1971; Mahar, 1976; Panagides and Magalahaes, 1974; Rosenbaum and Tyler, 1971; Sanders, 1973; Saunders, 1974; Wagley, 1974).

In 1973, with the completion of the road to Porto Vehlo, Manaus was finally included in the national highway system. Previously, the city had been dependent on river and air communications. The economy of the region was extractive in nature and, until the Decree Law 174 in 1966, Amazonas was essentially a colony of Brazil within itself (Foland, 1971). Internal security and relief of unemployment in the drought-stricken northeast were political realities that gave impetus to national planning (Rosenbaum and Tyler, 1971), and with the Decree Law 174/66 the military government under Umberto Castello Branco reformed the Amazonian Economic Development Superintendency (SPVEA) into the Superintendencia do Desenvolimento da Amazonia (SUDAM) along the lines of the SUDENE (Superintendencia de Desenvolimento de Nordeste). Investment funds were made available through tax mechanisms that have allowed a Brazilian company that locates in Manaus Federal tax reliefs of up to 50 percent (Mahar, 1976).

In addition, in 1967, the Decree Law 288/67 established the "Zona Franca da Manaus" (ZFM) and reduced or eliminated customs duties on may articles that moved in and out of Manaus. These two government economic stimulants have resulted in a boom in the Western Amazon Basin centered about Manaus giving that town a distorted industrial and commercial base (Mahar, 1976) dependent on present financial legislation.

The purpose of this paper is to test some of the spatial aspects of economic development in Amazonas, Brazil. Specifically, the research will examine the role of the city of Manaus as a regional growth center and determine whether growth there is merely of an enclave nature (leading to increasing rural-urban dualism) as Mahar (1976) fears; or whether there has been economic "backwash" into the rest of Amazonas in accordance with Brazilian regional development strategies.

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II. METHODOLOGY AND DATA

The following procedures will be utilized to achieve the research objectives: (i) derive three sets of surrogates of socio-economic well-being compiled on a municipality basis for the State of Amazonas; (ii) map the distribution of the surrogates to highlight spatial changes over time; (iii) empirically analyze the changing patterns of distribution over the periods in question; and (iv) compare those trends to those suspected by Mahar and those projected in the regional development plans.

The problems of the use of surrogate measures as indicators of social and economic conditions are well known, and Portes (1973) has voiced warnings on the blind use of sociological data on the grounds of availability, reliability, validity, and generalizability. Fortunately, Brazil has one of the most developed systems for the collection of national data of any Latin American country, and disregarding the problems of collection of empirical data in a semi-subsistence economy, the Demographic Census gatherings of 1950, 1960, and 1970 provide the best data available on a municipality basis over the entire time period. If one can assume that a normal distribution of data over the forty-four (twenty-five in 1950) municipalities exists and that the accuracy table presented with the 1970 Census is correct, then comparisons

of the three censuses will provide an indication of the trends over the two decade periods. Seven variables have been chosen on the basis of their continuity and consistency in definition over the three census periods, their applicability to economic development, and their frequency of usage in previous studies of underdeveloped countries (UNESCO, 1976: 97-99):

1. percentage of economically active persons, age 10 and over in agriculture;

2. percentage of economically active persons, age 10 and over in industry;

3. percentage of persons, age 10 and over, that are economically active;

4. percentage of residences with plumbing facilities;

5. percentage of residences with electric light;

6. percentage of students completing 12 years of education;

7. percentage of persons with no schooling.

III. DISCUSSION OF EMPIRICAL TECHNIQUES

Four recent empirical studies of pole-periphery growth in Latin America have encompassed a wide range of statistical techniques. Berry (1969) used multivariate analysis to establish the absence of "trickle-down" effects (the spreading down through all social and economic strata of the favorable impacts of growth at the center) in Chile and growing primacy of Santiago in relation to other cities in Chile. Semple, Gauthier and Youngman (1972) derived a growth index for each of 96 cities in the State of Sao Paulo, Brazil, for the time periods of 1940-1950 and 1950-1960, using the standardized scores from a factor analysis of nine variables. These indices were analyzed using the computer program GEOFIT (Cassetti and Semple, 1970) to determine the significant regional trends. Gilbert (1974) used factor analysis to derive a development surface about Medellin in Antioquia State, Colombia, in 1964. He tested this developmental surface using regression to variables such as distance from the growth center, the population density, and farm size, to name a few. He determined that the developmental surface could be best described in terms of decay in strength that is proportional to the logrithmic distance from the center, Medellin. The fourth study, that of Goias, Brazil, by Katzman (1975) treated the role of growth poles

and developmental highways more subjectively. Statistical support for his conclusion was derived from regression amongst distance, fertility, farmland in crops or pasture, farm labor force, rural population, and various crop prices. He concluded that the ". . . spatial development of Goias conforms well to predictions of the von Theunen model of land use. . . and . . . the Belem-Brasilia highway has had. . . far-reaching consequences on Goias" (Katzman, 1975: 105).

In some respects the previous studies have failed to come to grips with the dynamic nature of the development process, particularly changes with time. Development is not a short term process that can be modeled on the basis of a single time period. Changes over many decades are as significant as the state at one particular point in time, and studies that do not incorporate those changes are deficient.

Another deficiency that must be mentioned is the use of factor analysis to produce a single index of socio-economic well-being or standard-of-living in an effort to simplify the empirical techniques. Unfortunately, factor scores can overgeneralize to undefinable dimensions resulting in difficulty in interpretation; and additionally, factor analysis as an empirical technique is susceptible to many constraints in its operationalization (Rummel, 1970: 208-234) and one should approach its use with caution.

Perhaps a more relevant method of studying the social and economic effects of a growth center is that proposed by Casetti, King and Odland (1971), expanded by Odland, Casetti and

King (1973), and modified by Richardson (1976) to include the effects of backwash and spillover over time. Casetti, King and Odland (1971) state that a set of observations of a phenomenon may be constructed in terms of its frequency of occurence or intensity (Z), its access to the growth center, and when it occurred. The intensity of strength of the phenomenon may vary as a function of location (s) and time (t):

$$Z = Z\ (s,t) \qquad (i)$$

and may be expressed in the form:

$$Z = a_0 + a_1 t + a_2 s + a_3 st \qquad (ii)$$

where a_0 is constant, $a_1 . . . a_3$ are the coefficients with respect to time (t), accessibility (s), and the interaction between accessibility and time (st). In this fashion changing patterns in a phenomenon such as population density, the percentage of students that complete 12 years of schooling, or the percentage of economically active persons may be analysed using regression techniques. Graphically, the result would be a family of curves based on the interaction of time and access to the growth center (FIGURE I). Changes in the slopes would indicate changes in the increase in intensity with respect to a unit increase in access.

Theoretically, a variety of relationships would exist between the intensity of the phenomena, access to the growth center, and time. Good surrogates of accessibility in the case of Amazonas would be the distance by air and river from the focal point of activity within the state, Manaus. It is expected that intensity would decrease with respect to some form of increasing distance

FIGURE I

INTENSITY AS A FUNCTION OF

ACCESSIBILITY AND TIME.

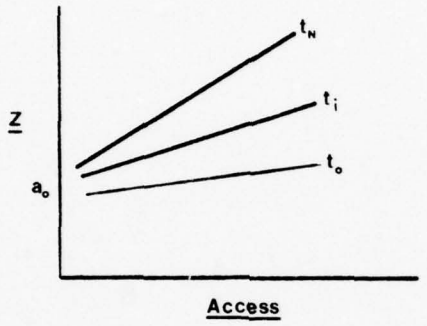
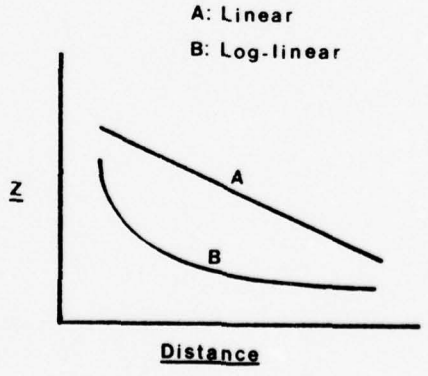


FIGURE II

DECAY OF INTENSITY OVER DISTANCE.



$$\text{ie.,} \quad \frac{\delta Z}{\delta s} < 0. \qquad \text{(iii)}$$

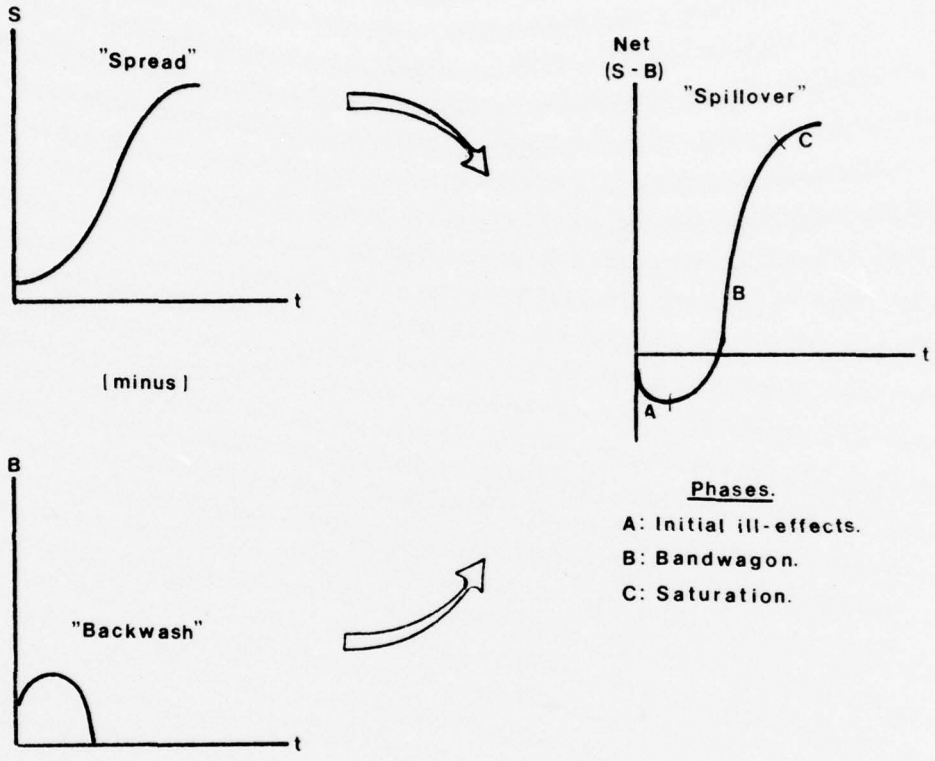
The nature of the relationship between intensity and distance could take forms other than a linear decay over distance. Gilbert (1975) discovered that though a linear relationship was statistically significant, the indices he derived correlated better with the $\log_e$ of the road distance from the growth center (FIGURE II).

Richardson (1976) states that the combined effects of spread and backwash change over time and may be divided into three phases (FIGURE III) ". . . a slow start; gathering momentum ('bandwagon' effect); and a slowing down process associated with saturation" (Richardson, 1976: 4). Initially any spread effects are overshadowed by backwash as resources gravitate towards the pole in the form of rural-urban migration and re-investment patterns. Spread effects generated by the increasing tempo of activity, however, diffuse toward the periphery surpassing backwash as the financial and social burden of urbanization is paid. As the markets become flooded, and as a drying up of opportunities occurs, or legislative emphasis is turned to other regions, the saturation stage is reached. The finite population and economically developable resource base combine with an overburdened transporation system or lack of capital to reduce the expansion rate.

Applying the spillover model of the change in intensity over time to the relationship of intensity with distance will produce a family of curves (FIGURE IV) that describes hypothetically

FIGURE III

THE SPILLOVER MODEL

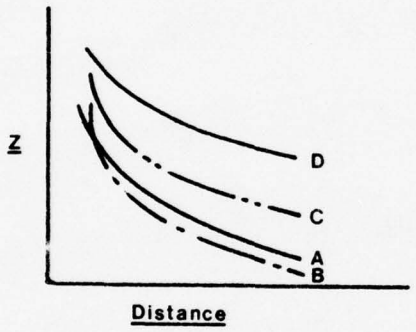


(after Richardson, 1976.)

FIGURE IV

INTERACTION EFFECTS OF TIME AND DISTANCE

ON THE INTENSITY OF A PHENOMENON



A: Prior to emphasis on development.

B: Initial ill effects.

C: Bandwagon effects.

D: Saturation, with an overall increase in development.

the initial development at the pole at the expense of the periphery, the diffusion of spread effects toward the hinterlands, and the final goal of a general increase in the phenomena over the entire region.

It must be realized that the great distances involved in travel in Amazonas, coupled with an absence of roads, have a substantial effect on accessibility and, consequently, on the success of the distance-decay model. It is more likely that there is a hierarchy of growth centers (Casetti, King and Odland, 1971: p. 378) and that development would emanate from a number of smaller centers, all of which are greatly overshadowed by the city of Manaus. The municipal population may well be a greater determinant of the distribution of a phenomena than distance from a growth center and must be included in the interaction model (i).

The intensity of a phenomenon may be seen as a function of both the product of distance from the growth center (x) and time (t), and of the municipal population (P) and time (t). Furthermore, time may act in a quadratic fashion, as in Stages A and B of Richardson's Spillover Model (FIGURE III), not in the linear fashion as proposed by Cassetti, King and Odland (1971). That is,

$$Z = Z(x) + Z(P) \qquad \text{(iv)}$$

where,

$$x = x(t) + x(t^2)$$

$$P = P(t) + P(t^2)$$

and which would result in the following equation:

$$Z = a_0 + a_1x + a_2P + a_3t + a_4xt + a_5Pt + a_6t^2 + a_7xt^2 + a_8Pt. \quad (v)$$

Graphically equation (v) describes a flat, tilted plan formed within the z, x, and P axes (FIGURE V), the height and tilt of which are changing over time. The reason for including time to the second power is the unlikelihood a phenomenon remaining in a steady state: that is, increasing or decreasing at exactly the same rate over time. It was recognition of these varying rates that originally led Perroux to develop the concept of the "Growth Pole" (Perroux, 1955, p. 279). Similarly, it would be simplistic to view intensity as decaying in a linear fashion over distances involved in Amazonas.

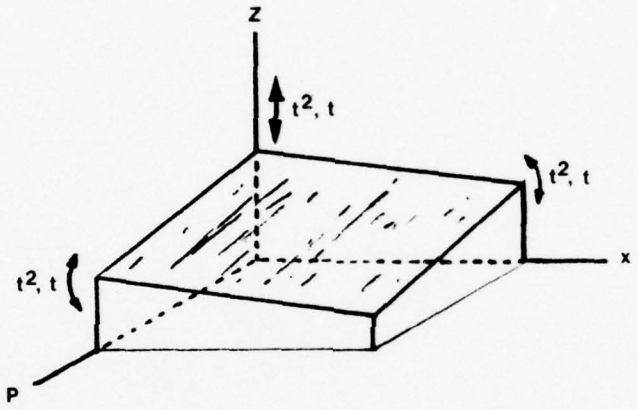
It would be illogical to view the entire state as Manaus's economic periphery, even though that is the case in Brazilian developmental planning (SUDAM, 1971). This circumstances is created by the inadequacy of transportation and the distances involved in Amazonas. It is more likely that local centers and social development would spring up at locations isolated from Manaus, but within Manaus's political sphere of influence. Such growth is inconsistent with a linear distance decay model. The use of a power series polynomial model for distance-decay, however, will not only show the local effects around the growth center, but also accommodates isolated smaller centers of growth. Limiting the polynomial to the fourth power would ease problems in computation and the model would be as follows:

FIGURE V

THEORETICAL SURFACE OF THE INTENSITY OF A PHENOMENON

AS A FUNCTION OF MUNICIPAL POPULATION AND DISTANCE

FROM THE GROWTH CENTER



$$Z = Z(x^4) + Z(x^3) + Z(x^2) + Z(x) + Z(P) \quad \text{(vi)}$$

where, $x = x(t^2) + x(t)$

and $P = P(t^2) + P(t)$.

The intensity of a phenomenon, such as the percentage of persons that are economically active, is a function of a fourth power polynomial of its distance from the growth center, Manaus, and a function of its municipal population. Both distance and population size are seen to vary as a quadratic function of time. Algebraically,

$$Z = \alpha + \beta_1 x + \beta_2 x^2 + \beta_3 x^3 + \beta_4 x^4 + \beta_5 P \quad \text{(vii)}$$

where, $\alpha = a_o + a_1 t + a_2 t^2$ (viii)

and $\beta_i = b_{io} + b_{i1} t + b_{i2} t^2$ (ix)

for each β_i, i = 1. . . 5. Substitution of equation (viii) and equation (ix) in equation (vii) yields: $Z = a_1 + a_2 x + a_3 P + a_4 t$

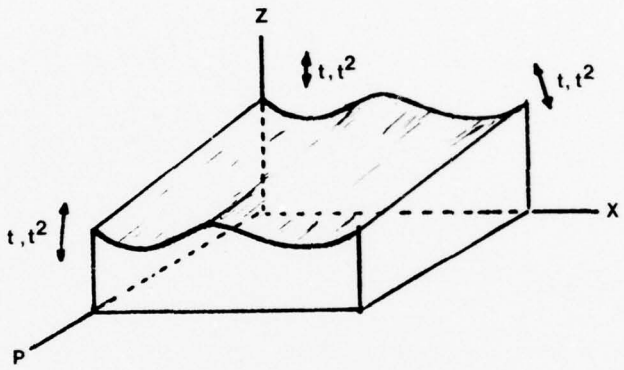
$$a_5 xt + a_6 Pt + a_7 x^2 + a_8 t^2 + a_9 Pt^2 + a_{10} x^2 t + a_{11} x^2 t^2 +$$

$$a_{12} x^3 + a_{13} x^3 t + a_{14} x^3 t^2 + a_{15} x^4 + a_{16} x^4 t + a_{17} x^4 t^2. \quad \text{(x)}$$

Graphically, equation (x) is a surface within the Z, X, and P axes (FIGURE VI), analagous to a sheet of corrugated material that tips, tilts, bends, and stretches as a function of time. Stepwise regression of each of the surrogates as the dependent variable will provide an empirical model of its distribution in terms of the size of municipal population and the distance of each municipal seat from the growth center, Manaus. Comparison of the regression results, their residuals, and the maps produced by SYMAP will test the validity of the model.

FIGURE VI

THE THEORETICAL SURFACE OF THE INTENSITY OF A PHENOMENON AS A FUNCTION OF MUNICIPAL POPULATION AND OF A FOURTH ORDER POLYNOMIAL OF DISTANCE FROM THE GROWTH CENTER.



IV. RESULTS

Three general remarks should be made concerning the results before dealing with the variables individually. Firstly, the maps portray data distribution within the interpolation constraints internal to the "SYMAP" program. The fact that there were no data points in the North-East and South-East extremes of Amazonas allowed data points that differed substantially from surrounding points (Manaus on Map V, Ilha Grande on Map VI, and Novo Aripuana on Map X) to "tail" toward the North or South-East, depicting patterns that may not actually exist. Secondly, the size of the computer printout, which was printed at ten lines to the inch horizontally and eight lines to the inch vertically, was determined by the available means of photo-reduction and led to a loss of clarity of exactly where the contours occur on the map. For example, on Map III and Map IV the gradient between Manaus and the surrounding municipal seats is so extreme that there is little room on the map for all the appropriate contour lines.

Thirdly, the results of the regression analyses (TABLE II) showed the municipal population to be more of an indicator of the intensity of the variable than distance from the growth center, though distance was significant in three of the seven

TABLE II

REGRESSION RESULTS AND KEY TO VARIABLES.

VARIABLE	CONSTANT	ADFM	MPOP	t	xt	Pt	x^2	t^2	Pt^2	x^2t	x^2t^2	x^3	x^3t	x^3t^2	x^4	x^4t	x^4t^2	R	R^2
%AGR	-728.72		-0.03	+252.7				-19.4										.94	.88
%IND	-2.80			+0.72					+0.0002									.71	.50
%EAP	665.47			-195.7				+14.97										.95	.91
%RPG	-9.75		+0.05			-0.004		+00.23										.87	.76
%REL	-14.54		+0.04	+2.62		-0.004												.86	.75
%12S	-0.004								+.00003									.90	.82
%NOS	57.74	+0.023							-0.0003									.71	.50

VARIABLE	CONSTANT	LADM	MPOP	t	xt	Pt	x^2	t^2	Pt^2	x^2t	x^2t^2	x^3	x^3t	x^3t^2	x^4	x^4t	x^4t^2	R	R^2
%AGR	-55.83		-0.03	+21.49	+9.41		-12.3				-0.39		-0.71		-0.13		-0.003	.94	.88
%IND	-2.80			+0.72					+0.0002									.71	.50
%EAP	665.47			-195.7				+14.97										.95	.91
%RPG	-9.75		+0.05			-0.004		+0.23										.87	.76
%REL	-14.54		+0.04	+2.63		-0.004												.86	.75
%12S	1.93		-.002		-0.20				+0.0001	+0.02	+0.003						-.00004	.93	.86
%NOS	42.26						+0.93	-0.21										.70	.49

TABLE II (continued)

VARIABLE	CONSTANT	RDFM	MPOP	t	xt	Pt	x^2	t^2	Pt^2	x^2t	x^2t^2	x^3	x^3t	x^3t^2	x^4	x^4t	x^4t^2	R	R^2
%AGR	-728.27		-0.03	+252.7				-19.40										.94	.88
%IND	-2.80			+0.72					+0.0002									.71	.50
%EAP	665.47			-195.9				+14.49										.95	.91
%RPG	-9.75		-.047			-0.004		+0.229										.87	.76
%REL	14.54		-0.04	+2.62		-0.004												.86	.75
%12S	-0.004								+.00003									.90	.81
%NOS	51.19	+0.035					-.00001		-.00023									.78	.60

VARIABLE	CONSTANT	LRDM	MPOP	t	xt	Pt	x^2	t^2	Pt^2	x^2t	x^2t^2	x^3	x^3t	x^3t^2	x^4	x^4t	x^4t^2	R	R^2
%AGR	-52.76		-0.03	+20.31	+9.25		-11.0				-0.35		+0.58		-0.095		-0.002	.94	.88
%IND	-2.80			+0.72					+0.0002									.71	.50
%EAP	673.44			-196.7				+14.9					+0.008		-0.006			.95	.91
%RPG	-9.75		+0.047			-0.004		+0.23										.86	.75
%REL	-14.54		+0.044	+2.63		-0.004												.86	.75
%12S	-0.004								+.00003									.90	.82
%NOS	48.79			-2.46			+0.86											.75	.57

TABLE II (continued)

KEY TO VARIABLES.

%AGR - Percentage of economically active persons, age ten and over, employed in agriculture.

%IND - Percentage of economically active persons, age ten and over, employed in industry.

%EAP - Percentage of persons that are economically active.

%RPG - Percentage of residences with plumbing facilities.

%REL - Percentage of residences with electric lights.

%12S - Percentage of persons, age five and over, who have completed twelve years of schooling.

%NOS - Percentage of persons, age five and over, who have not attended school.

ADFM - Air distance from Manaus.

LADM - Log_e (Air distance from Manaus).

RDFM - River distance from Manaus.

LRDM - Log_e (River distance from Manaus).

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variables (%AGR, %12S and %NOS). Furthermore, at a significance level of .05, three variables (%IND, %RPG and %REL) yielded the same equations regardless of the criteria used to measure distance. One equation was selected for each variable (TABLE III) on the basis of its coefficient of determination (R^2) and its surfaces were analyzed graphically to detect trends that would correspond to Richardson's Spillover Model (Richardson, 1976). The theoretical surfaces were then compared to the "SYMAP" maps in an attempt to test their veracity.

The percentage of economically active persons age ten and over employed in agriculture, presented a complex surface related to municipal population, the first, second, and fourth powers of the $\log_e$ of the river distance from Manaus, which varied quadratically with time (FIGURE VII). Generally, the percent of economically active persons employed in agriculture decreased as the municipal population increased though the overall percentages increased with each census period. With respect to distance the percentage initially increased rapidly, peaked and dropped off with distance in 1950. This effect is not readily apparent on MAP II because of the levels chosen in the mapping program, and because the map portrays merely the spatial distribution of the values. Inspection of the regression residuals shows the surface to be close to the actual values shown on the map. In 1960 and 1970 there were a number of large negative residuals -- municipalities such as Benjamin Constant that have a much lower percentage employed in agriculture than would be ex-

TABLE III

EQUATIONS SELECTED FOR FURTHER ANALYSIS.

A: Normal Coefficients.

$\%AGR^{1} = -52.76 - 0.03P + 20.3t + 9.25xt - 11.0x^{2} - 0.35x^{2}t^{2} + 0.58x^{3}t - 0.95x^{4} - .002x^{4}t^{2}.$

$\%IND = -2.8 + 0.72t + .0002Pt^{2}.$

$\%EAP^{1} = 673.4 - 196.7t + 14.89t^{2} + .008x^{3}t - .006x^{4}.$

$\%RPG = -9.75 + 0.05P - .004Pt + 0.23t^{2}.$

$\%REL = -14.5 + .04P + 2.63t - .004Pt$

$\%12S^{2} = 1.93 - .002P - 0.20xt + .0001Pt^{2} + 0.02x^{2}t + .003x^{3}t^{2}.$

$\%NOS^{3} = 51.19 + .035x - .00001x^{2} - .0002Pt^{2}.$

B: Standardized Coefficients.

$\%AGR^{1} = -52.76 - 0.5P + 0.8t + 4.3xt - 6.7x^{2} - 10.7x^{2}t^{2} + 20.6x^{3}t - 4.3x^{4} - 4.0x^{4}t^{2}.$

$\%IND = -2.80 + 0.72t + 0.13Pt^{2}.$

$\%EAP^{1} = 673.4 - 10.9t + 13.5t^{2}\ 0.4x^{3}t - 0.4x^{4}.$

$\%RPG = -9.75 + 2.2P - 1.2Pt + 0.3t^{2}.$

$\%REL = -14.54 + 1.8P + 0.2t - 1.0Pt.$

$\%12S^{2} = 1.93 - 1.5P - 3.6xt + 1.8Pt^{2} + 2.2x^{2}t + 2.7x^{2}t^{2}.$

$\%NOS^{3} = 51.19 + 1.6x - 1.1x^{2} - 0.2Pt^{2}.$

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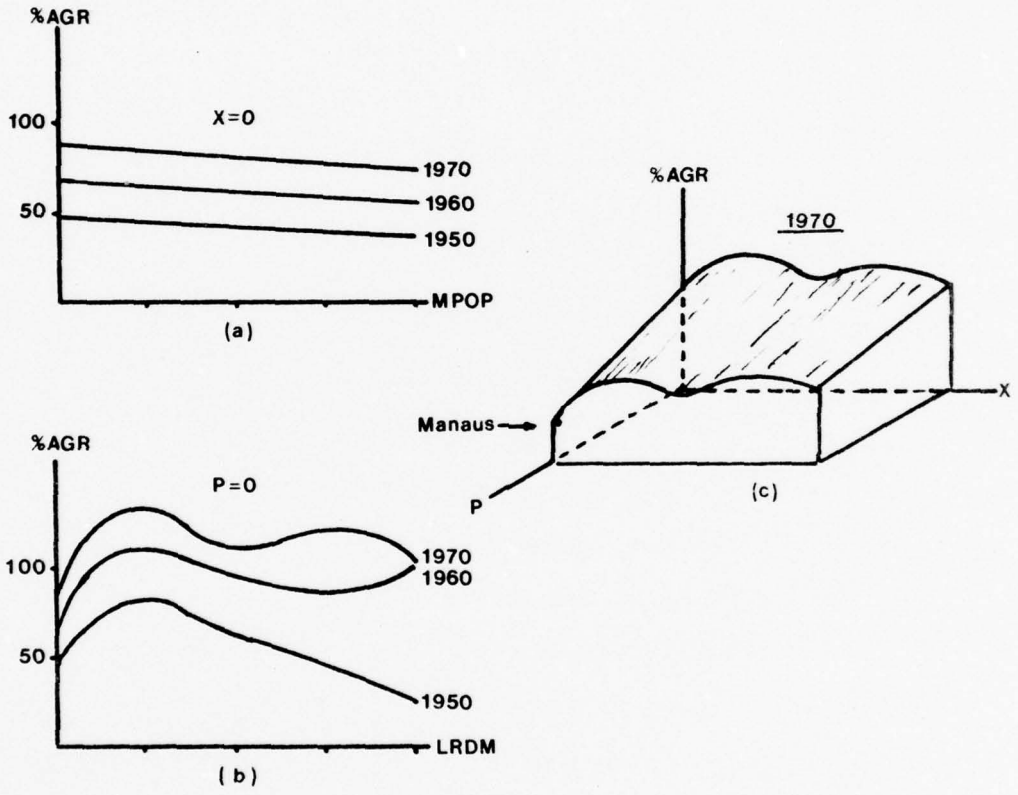
^{1}x = LRDM, ^{2}x = LADM, ^{3}x = RDFM, P = MPOP, t = CNYR.

FIGURE VII

THE PERCENTAGE OF ECONOMICALLY ACTIVE PERSONS, AGE TEN AND OVER EMPLOYED IN AGRICULTURE 1950-1970.



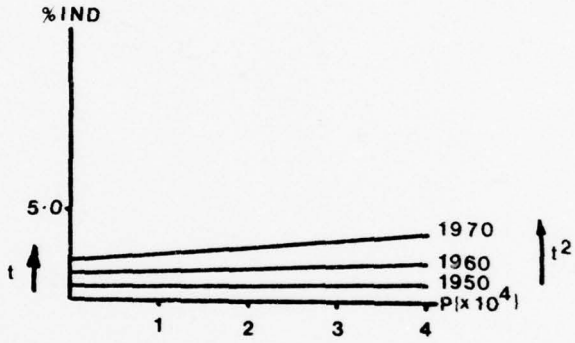
pected. Though direct comparison of a cross section of the model to the map is not possible because of the interaction of population size on the change with distance, certain similarities exist between cross sections and the map. In 1970, there is a very low percentage in the municipality of Manaus which increases rapidly to a peak that diminishes and then peaks again near the western extremes of the map.

The surface described by the equation for the percentage of economically active persons, age ten and over employed in industry, (Figure VIII) were not as complex as those for agriculture. The percentage of persons employed in industry was independent of distance from Manaus and was a function of municipal population and time. Changing values of a_o (the constant) showed the industrial base to be increasing slowly (0.7% per decade) while the slope increased as a function of t^2. This indicates the rate at which percentage of persons employed in industry was increasing with expanding municipal population is increasing at a geometric rather than arithmetic rate. In short the percentage of persons employed in industry was beginning to "snowball" with time while remaining a function of municipal population.

The percentage of persons that are economically active had no statistically significant relationship to municipal population or to distance from the growth point in three of the four distance criteria. The fourth, the $\log_e$ of the river distance from Manaus (FIGURE IX), showed a slight significant relationship, though the percentage of persons that were economically active varied strongly

FIGURE VIII

THE PERCENTAGE OF ECONOMICALLY ACTIVE PERSONS, AGE TEN AND OVER, EMPLOYED IN INDUSTRY, 1950-1970.



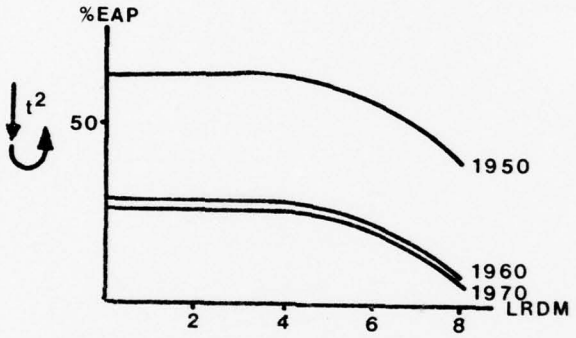
$\%IND_5 = 0{\cdot}8 + {\cdot}005\ P$

$\%IND_6 = 1{\cdot}5 + {\cdot}007\ P$

$\%IND_7 = 2{\cdot}2 + {\cdot}010\ P$

FIGURE IX

THE PERCENTAGE OF PERSONS, AGE TEN AND OVER, THAT ARE ECONOMICALLY ACTIVE, 1950-1970.



$$\%EAP_5 = 62{\cdot}4 + {\cdot}04x^2 - {\cdot}006x^4$$
$$\%EAP_6 = 29{\cdot}2 + 05x^2 - {\cdot}006x^4$$
$$\%EAP_7 = 26{\cdot}1 + {\cdot}06x^2 - {\cdot}006x^4$$

as a quadratic function of time (TABLE III, standardized coefficients). The fact that there were only three large regression residuals out of 113 cases and the high coefficient of determination shows how closely the equation followed the variation in the data set. Comparison of the three maps, for 1950, 1960, and 1970, heightens the notion that the variable is aspatial. Little discernible spatial trend can be seen among the three time periods FIGURE IX).

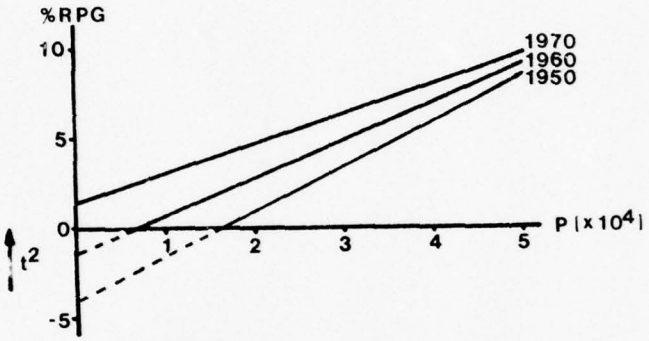
The results for the percentages of residences with plumbing facilities (FIGURE X) and the percentage of residences with electric lights (FIGURE XI) were similar in nature. Both variables were functions of municipal population and time. The change in gradient with increase in time was negative, showing that for a pair of municipalities over the three census periods, the difference between them is becoming less over time.

An interesting difference between the two sets of equations was that, whereas plumbing showed a statewide growth that was increasing as a quadratic function of time, electricity was only increasing as a linear function of time on a statewide basis. The latter effect is not readily apparent from the maps because of the overall low percentages involved. It was not until 1970 that a number of towns exceeded ten percent in either case.

The percentage of students, age 5 and over, who have completed twelve years of schooling, like the percentage of economically active persons employed in agriculture, formed a complex multivariate surface (FIGURE XII). The percentage of students

FIGURE X

THE PERCENTAGE OF RESIDENCES WITH PLUMBING FACILITIES, 1950-1970.



$\%RPG_5 = -4{\cdot}00 + {\cdot}025P$

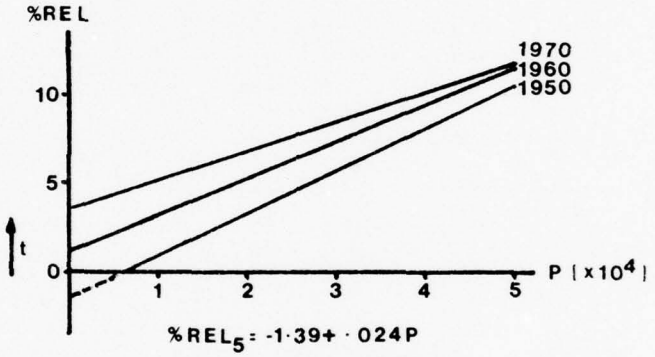
$\%RPG_6 = -1{\cdot}47 + {\cdot}021P$

$\%RPG_7 = 1{\cdot}52 + {\cdot}016P$

FIGURE XI

THE PERCENTAGE OF RESIDENCES WITH

ELECTRIC LIGHTS, 1950-1970.



$\%REL_5 = -1.39 + .024P$

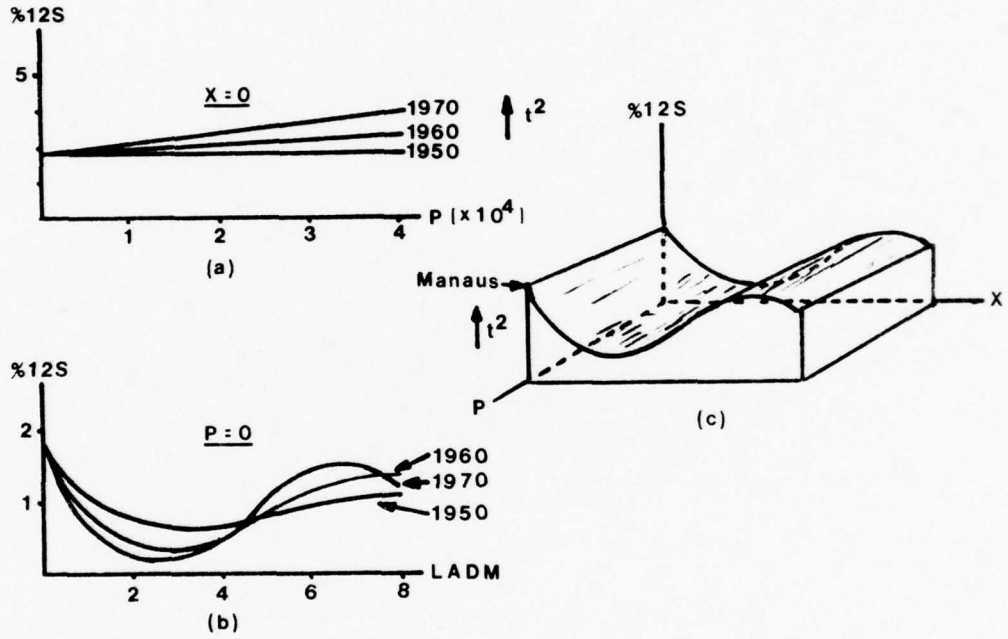
$\%REL_6 = 1.24 + .020P$

$\%REL_7 = 3.87 + .016P$

FIGURE XII

THE PERCENTAGE OF STUDENTS, AGE FIVE AND OVER,

WHO HAVE COMPLETED TWELVE YEARS OF SCHOOLING, 1950-1970.



who have completed twelve years of school increased with municipal population and that rate of increase increased as a quadratic function, having a self-generating effect ("snowballing") that was more apparent in the more populous municipalities. The relationship to distance from Manaus was polynomic. In 1950, there was an initial sharp decreased which leveled off and began an increase in percentage with distance. In 1960 and 1970 this rise became progressively closer to the pole and more rapid so that a "peak" was reached (in 1970) of approximately 500 kilometers out. This effect coincides with the patterns on MAP XIX though inspection of the residuals showed values at Sao Gabriel da Cacoiera, Ilha Grande, and Maues to be higher than would be expected from the multi-variate surface.

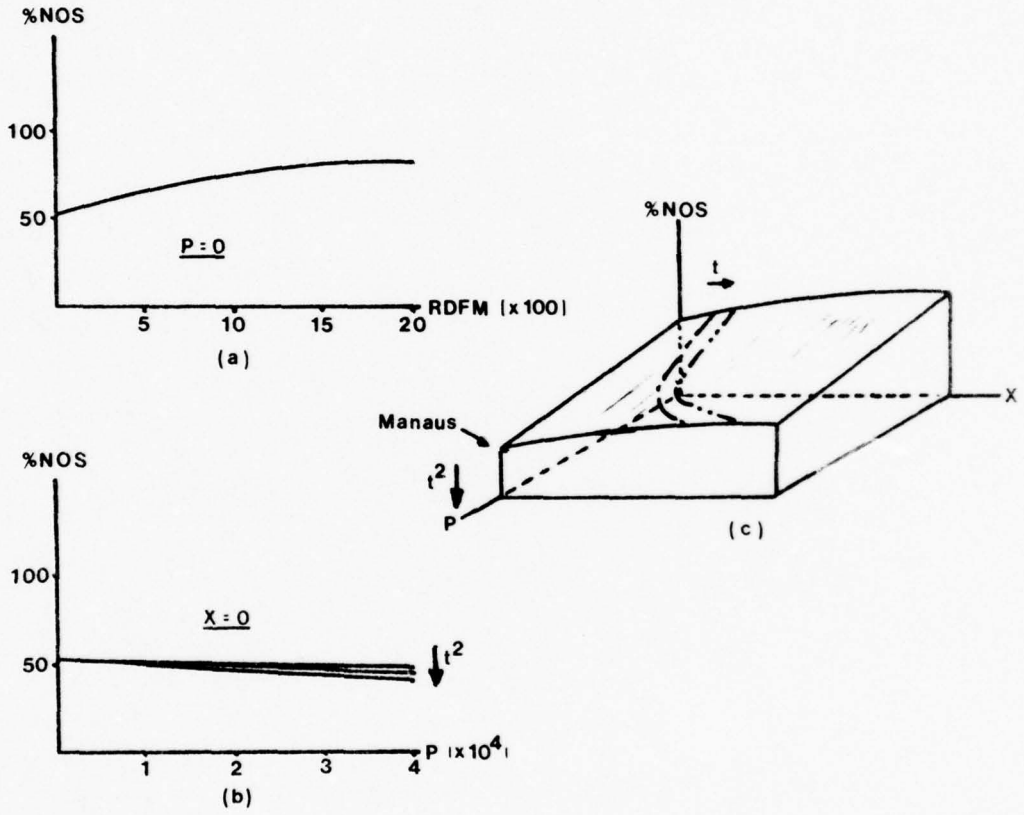
The last variable, the percentage of persons, age five and over, who have not attended school, was a function of the river distance from Manaus (FIGURE XIII) and of municipal population. The percentage of persons with no schooling rose with distance to a peak about 1,500 kilometers from the pole and then declined slightly. The percentage decreases with increasing municipal population and the rate of decrease is increasing as a quadratic function of time. If the 70 percent contour were to be plotted on the surfaces for 1950, 1960, and 1970, the contour would recede away from higher population municipalities with increasing time. This effect is readily apparent on MAP XX, MAP XXI, and MAP XXII.

From the results it may be said that each variable showed its own distinct relationship between its intensity, distance from

FIGURE XIII

THE PERCENTAGE OF PERSONS, AGE FIVE AND OVER,

WHO HAVE NOT ATTENDED SCHOOL, 1950-1970.



the growth center, municipal population, and time. It remains to be seen whether the resulting multivariate surfaces show trends that could be construed as following Richardson's Spill-over Model (FIGURE III).

V. INTERPRETATIONS AND CONCLUSIONS

The most important trend in the results is the very minor role that distance played in the empirical analysis of the patterns of distribution. This circumstance is not surprising. One of the underlying assumptions of a theory of central places, such as growth-center theory, is that population is fairly evenly distributed over a homogeneous plain. The case of Amazonas with its unbalanced population distribution, underdeveloped transportation net, and vast distances, makes a mockery of these assumptions. In this respect, Amazonas is not dissimilar to many other regions of Latin America where spatial imbalances, great distances, and deficient transportation networks cause theories conceived in and for western industrialized nations to be suspect (Richardson and Richardson, 1975: 165-166). Surprisingly, however, in three cases, %AGR, %12S and %NOS, distance did prove to be a significant variable in explaining the data distribution.

The results for %AGR and %12S (FIGURE VII, FIGURE XII, MAPS III, IV, XX, XXI and XXII) show local spread effects in the immediate vicinity of Manaus that are not incongruous to growth-center theory. Gilbert found similar patterns in the vicinty of Medellin, Colombia (Gilbert, 1974: p. 46), that indicated the areas within which "trickle-down" effects might be found were

confined to commuting distance from major urban centers. Agriculture has been replaced within the Municipio of Manaus by other land uses resulting in a low value of %AGR. The first "hump" in the 1970 curve (and only hump in 1950 and 1960) is the result of commercial agriculture, livestock, and forestry (all in the same census category) that have developed around Manaus in response to the market there. Saunders (1974: 176) mentions the beneficial impact the market of Manaus has had on the surrounding livestock industry; an effect similar to that Katzman (1975: 100-101) found surrounding Brasilia concerning dairying and vegetable farming.

The percentage of students who completed twelve years of schooling was understandably high in the Municipio of Manaus, the center of a government, development agencies, industry, and social-cultural activities. The institutionalized dislike of upper level managers and cultural elites to rural living in Latin America is well known (Richardson and Richardson, 1975: 167) and Brazil is no exception. Panagides and Magalhaes (1974: 254) cited an annual turn-over of ninety percent amongst the 80-member managerial staff at the Altamira agricultural settlement project in 1972. The fact that the project should have had a staff of 500, 180 of which should have been in professional-technical categories, gives an idea of the problem and a reason for the sharp drop in the %12S curve with increasing distance from Manaus (FIGURE XI). The development of the "hump" in the 1960 to 1970 period is the result of the increase in numbers of in-

dividuals in middle-sized municipios (population over 10,000) such as Novo Aripuana where, in 1970, 144 persons qualified in a municipal population of 13,879, which is 1.04%, the highest in the state after Manaus. The reason for the unusual concentration of persons who have completed twelve years is not readily apparent and could be an object of further research.

The third variable that exhibited a significant coordination with distance from Manaus was "the percentage of persons, age five and over, who have not attended school. The receding seventy percent contour mentioned previously could well be the result of government inspired literacy programs tempered spatially by the effects of rural-urban migration. Literacy programs, such as "Cruzada ABC", in effect from 1946 to 1970 (Weil, 1976: 149), were part of a national effort to eradicate illiteracy. Mobilized from the towns, and using schools, churches and houses as classrooms, the program was aimed at adults. The success of the program would account for the increasing tendency for %NOS to diminish in time in towns of the same size, and to diminish as a function of increasing town size. What is not explained, however, is the band of high percentage of persons with no schooling that has developed around Manaus at Manacapuru in 1960, and Airao and Codajas in 1970. Possibly this unusually high percentage is the result of out-migration of the more educated to the opportunities of Manaus, leaving the educationally handicapped behind.

The patterns of the remaining four variables, %EAP, %RPG, %REL and %IND are empirically a function of municipal population

and its changes with time. The percentage of persons, age five and over, that are economically active reflected a trend that has been widespread in Latin American countries. Weil (1975: 39) states that

> . . . the decline in the overall participation rate (as labor) that was registered during the 1960's is a phenomenon frequently found in developing countries, and during the 1960's it was common in Latin America, where the I. L. O. estimated that the rate declined by and average of 1.6 percent. This phenomenon stems primarily from a high birthrate, causing an increasingly large proportion of the population to be too young to work, from an improving and expanding educational system that defers the labor force participation of an increasing number of young people, and from an expanding social security system that permits the retirement of an increasing number of elderly workers. All these forces were at work in Brazil in the 1960's.

Though there is little evidence of a national social security system prior to 1964 when the government started to consolidate the "caixas" or pension funds into a comprehensive welfare system (Skidmore, 1973: 34), this fact combined with national pressures to populate a vast underdeveloped country (Merrick, 1976: 181) and with a drop in infant mortality has led to substantial increases in the ranks of the economically inactive; and the patterns shown in Amazonas are a manifestation of national trends.

The percentages of residences with plumbing facilities and that with electric lights both reflect increasing statewide standards of living, even though the percentages are low. The "snowball" increase in plumbing facilities very likely reflects government efforts to improve health standards and the expansion of housing facilities that have had plumbing incorporated into

their design in planned agricultural settlements. The percentage of residences with electric lights is not growing as fast (only linearly) and this is very likely the result of the high initial expense of developing electrical distribution systems. In both cases the growth is heavily urban rather than rural (IBGE, 1968: 164; IBGE, 1973: 269).

The remaining variable, the percentage of economically active persons, age ten and over, who are employed in industry, reflects the weak industrial base throughout the state. The base appears to be growing at 0.7 percent per year in the villages with a faster growth in more populous municipalities. The fact that the rate of change of increase with population appears to be increasing as a quadratic function of time is encouraging. Projects such as the SIDERAMA steel processing project approved by SUDAM for Manaus (Panagides and Magalhaes, 1974: 257) could help the economic climate if it was not for the spatial isolation of Manaus from the rest of Brazil.

Industry in Amazonas centered on the Free Trade Zone of Manaus (Zona Fronca de Manaus or ZFM) has not been without its social and economic costs. The surge of readily available duty-free luxury goods that flows through the town for disbursement by air to other centers of Brazil (Mahar, 1976: 371-372) has caused an adverse balance of payments, along with tax revenue losses, that must be borne by the nation as a whole (Rosenbaum and Tyler, 1971: 423). Additionally, a number of nascent manufacturing industries in Manaus were not able to withstand the

removal of protective tariffs and have succumbed to the importation of "better" foreign products (Ibid). Considerations such as these just cited resulted in changing attitudes towards the use of growth poles and growth centers in Brazilian development strategies (Ibid: 429-431). To continue as a viable operational strategy toward regional development growth pole and growth center will require modification, such as those offered by Darkoh (1977).

Darkoh is of the opinion that growth center concepts have to be modified by the social, political, economic and historical realities of the region where they are to be applied. Growth centers should be planned so as to foster spatial integration and lessen external dependencies (Darkoh, 1977: 20). This has not been the case in Amazonas. Very little evidence of spatial integration in the empirical analysis exists and the fact that the ZFM is dependent on external trade shows little likelihood that the economic "boom" in Manaus would be self-sustaining and continue if the financial and tax incentives were removed.

A second goal of growth center concepts, if they are to have relevance as an operational strategy for developing countries, should be that they provide a link between the structure of production and the needs of society (Ibid). Re-iteration of the socio-economic results of the ZFM cited previously from Rosenbaum and Tyler (1971: 423) shows that this goal is not being achieved in Manaus. Mahar (1976) studies this aspect in depth and con-

cludes that, though there has been substantial betterment in employment and income, the development induced is dependent on imputs shipped or flown to Manaus at high real cost. There is, therefore, much doubt as to the permanency of such development, and the "screwdriver" industries have caused flows of labor and capital to, rather than from, Manaus. This situation emphasizes the "enclave" nature of development rather than the spread of economic benefits outward (Mahar, 1976: 376).

On the positive side, development in Manaus has strengthened intersectoral and spatial linkages of the national economy and the completion of the road building program will bring Manaus into the national road transportation network. Establishment of the SUDAM has created an administrative body that could foster new patterns of diffusion of information and innovation and will hopefully be freer of the political ills that seem to plague autonomous agencies in Latin America.

The results of the empirical analysis bear out the conclusion that spread effects from Manaus have been local if non-existent in the case of the surrogates tested. In three cases, distance from Manaus was significant in a complex multivariate polynomial involving municipal population and interaction with time, but for the most part, the municipal population was the most significant determinant in the intensity of the surrogates, followed by time. One implication of these conclusions is that if the social-economic goals implicit in the current development plans

such as "POLAMAZONIA" are to be achieved, then a redesign of legislative, fiscal, and political strategies is a necessity.

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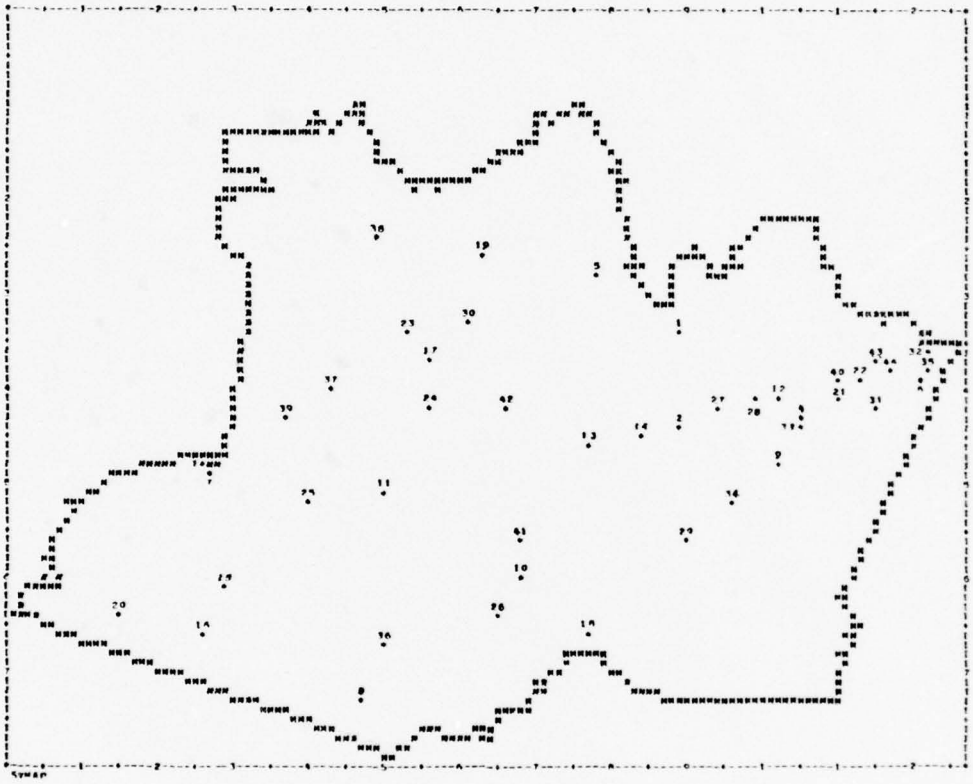
MAP I

AMAZONAS: KEY TO MUNICIPAL SEATS

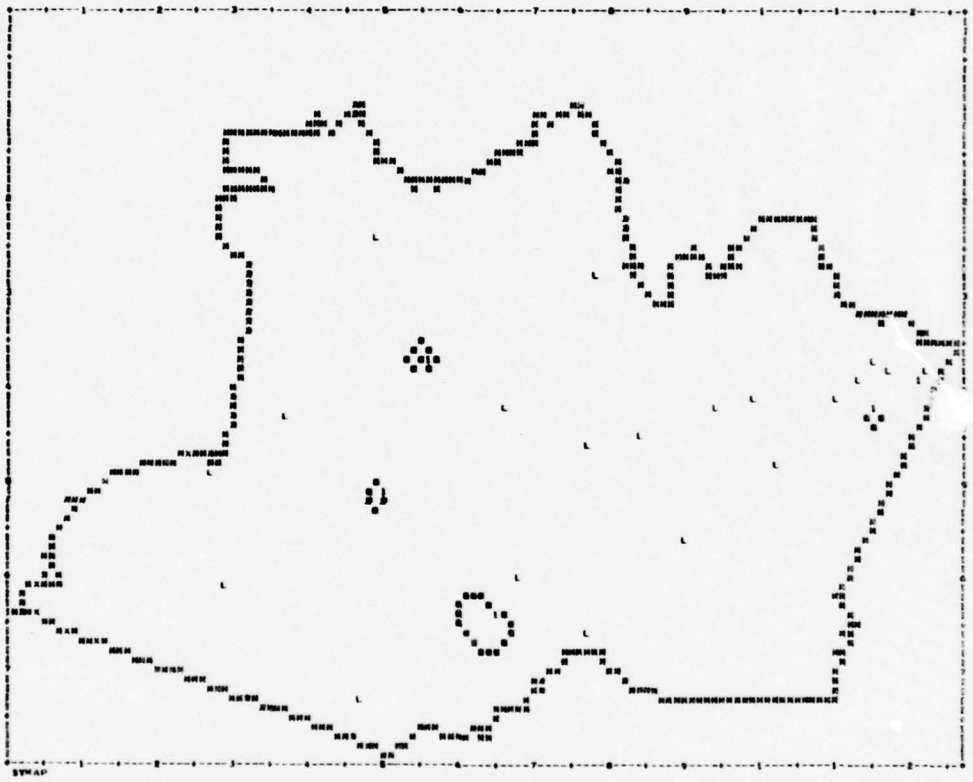


AMAZONAS: KEY TO MUNICIPAL SEATS.

1. AIRAO.
2. ANORI.
3. ATALAIA DO NORTE.
4. AUTAZES.
5. BARCELOS.
6. BARREIRINHA.
7. BENJAMIN CONSTANT.
8. BOCA DO ACRE.
9. BORBA.
10. CANUTAMA.
11. CARAUARI.
12. CAREIRO.
13. COARI.
14. CODAJAS.
15. EIRUNEPE.
16. ENVIRA.
17. FONTE BOA.
18. HUMAITA.
19. ILHA GRANDE.
20. IPIXUNA.
21. ITACOATIARA.
22. ITAPIRANGA.
23. JAPURA.
24. JURUA.
25. JUTAI.
26. LABREA.
27. MANACAPURU.
28. MANAUS.
29. MANICORE.
30. MARAA.
31. MAUES.
32. NHAMUNDA.
33. NOVA OLINDA DO NORTE.
34. NOVO ARIPUANA.
35. PARINTINS.
36. PAUINI.
37. SANTO ANTONIO DO ICA.
38. SAO GABRIEL DA CACHOEIRA.
39. SAO PAULO DE OLIVIENCA.
40. SILVES.
41. TAPAUA.
42. TEFE.
43. URUCARA.
44. URUCURITUBA.

MAP II

AMAZONAS: PERCENTAGE OF ECONOMICALLY ACTIVE PERSONS, AGE TEN AND OVER EMPLOYED IN AGRICULTURE--1950.



Scale: Approximately 1:14.5 million.

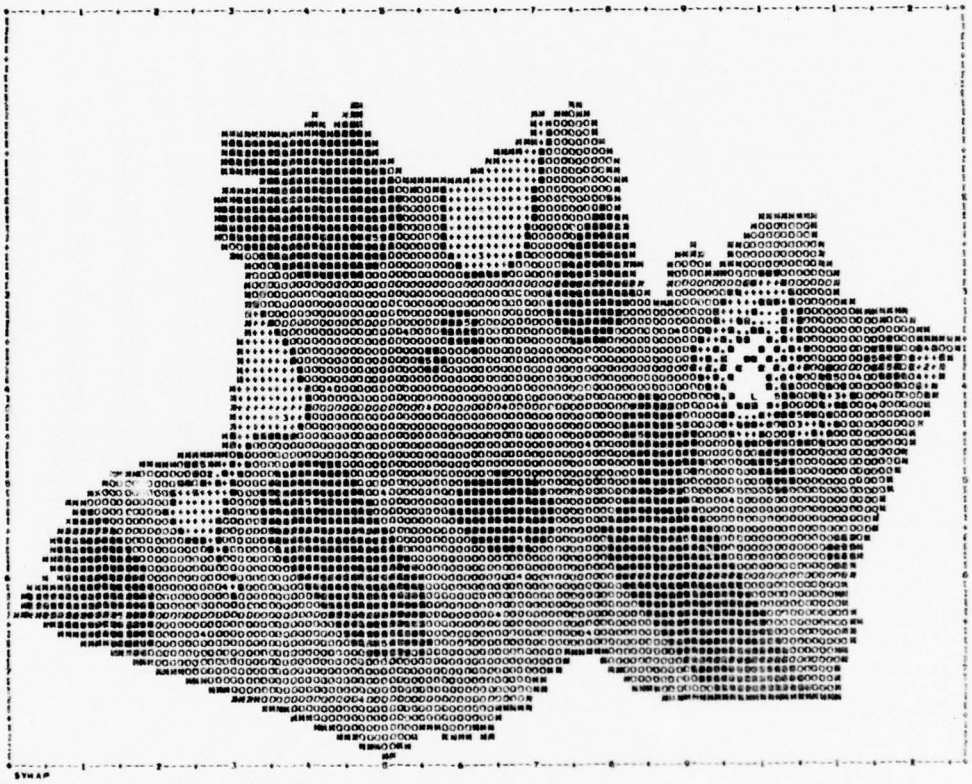
KEY TO PERCENTAGE LEVELS

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	BELOW	50.00	60.00	70.00	80.00	90.00
MAXIMUM	50.00	60.00	70.00	80.00	90.00	100.00
LEVEL	L	1	2	3	4	5
SYMBOLS	L	1	2	3	4	5

MAP III

AMAZONAS: PERCENTAGE OF ECONOMICALLY ACTIVE PERSONS, AGE TEN AND OVER EMPLOYED IN AGRICULTURE--1960.



Scale: Approximately 1:14.5 million

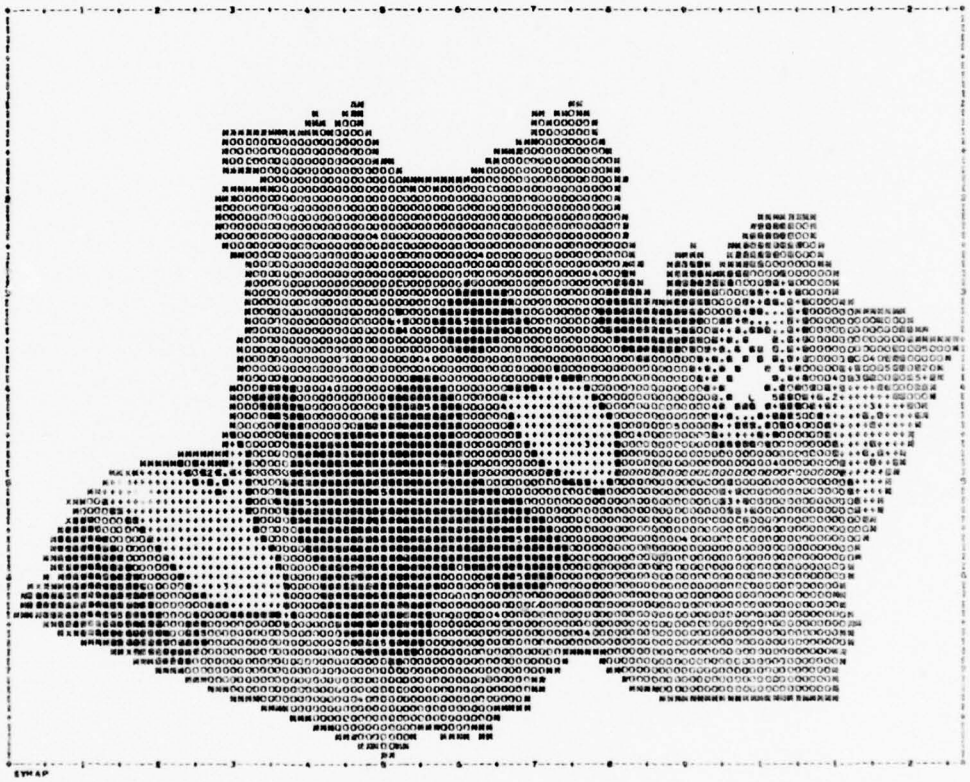
KEY TO PERCENTAGE LEVELS

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	BELOW	50.00	60.00	70.00	80.00	90.00
MAXIMUM	50.00	60.00	70.00	80.00	90.00	100.00
LEVEL	L	1	2	3	4	5
SYMBOLS	L	1	2	3	4	5

MAP IV

AMAZONAS: PERCENTAGE OF ECONOMICALLY ACTIVE PERSONS, AGE TEN AND OVER, EMPLOYED IN AGRICULTURE--1970.



Scale: Approximately 1:14.5 million.

KEY TO PERCENTAGE LEVELS

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

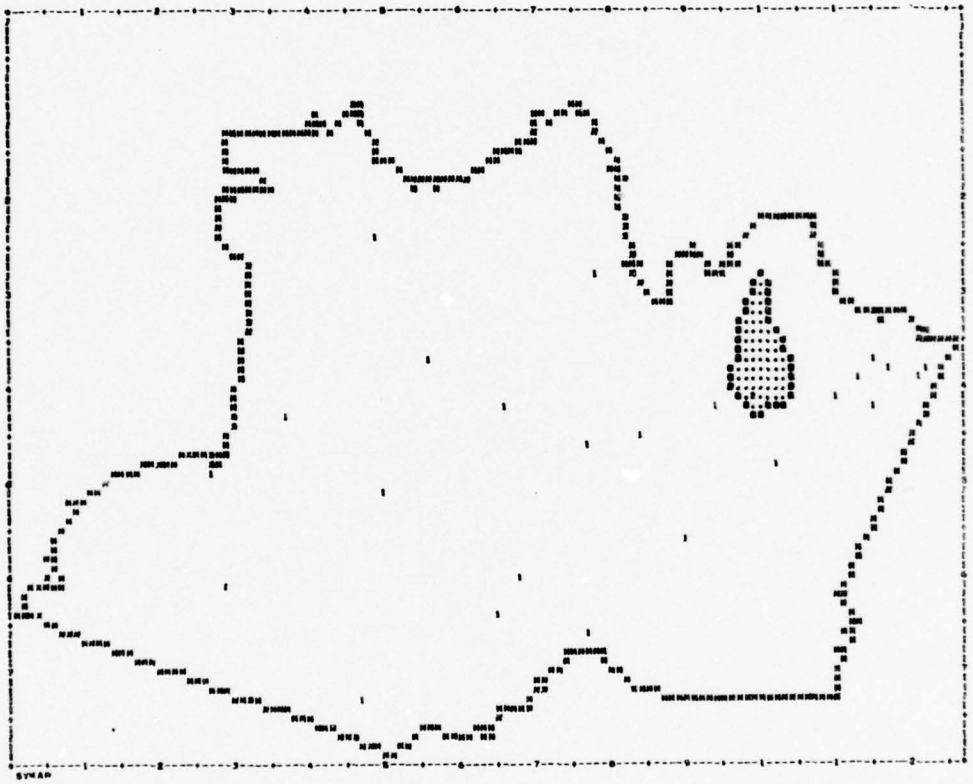
MINIMUM	BELOW	50.00	60.00	70.00	80.00	90.00
MAXIMUM	50.00	60.00	70.00	80.00	90.00	100.00
LEVEL	L	1	2	3	4	5
SYMBOLS	L	1	2	3	4	5

MAP V

AMAZONAS: PERCENTAGE OF ECONOMICALLY

ACTIVE PERSONS, AGE TEN AND OVER,

EMPLOYED IN INDUSTRY--1950.



Scale: Approximately 1:14.5 million.

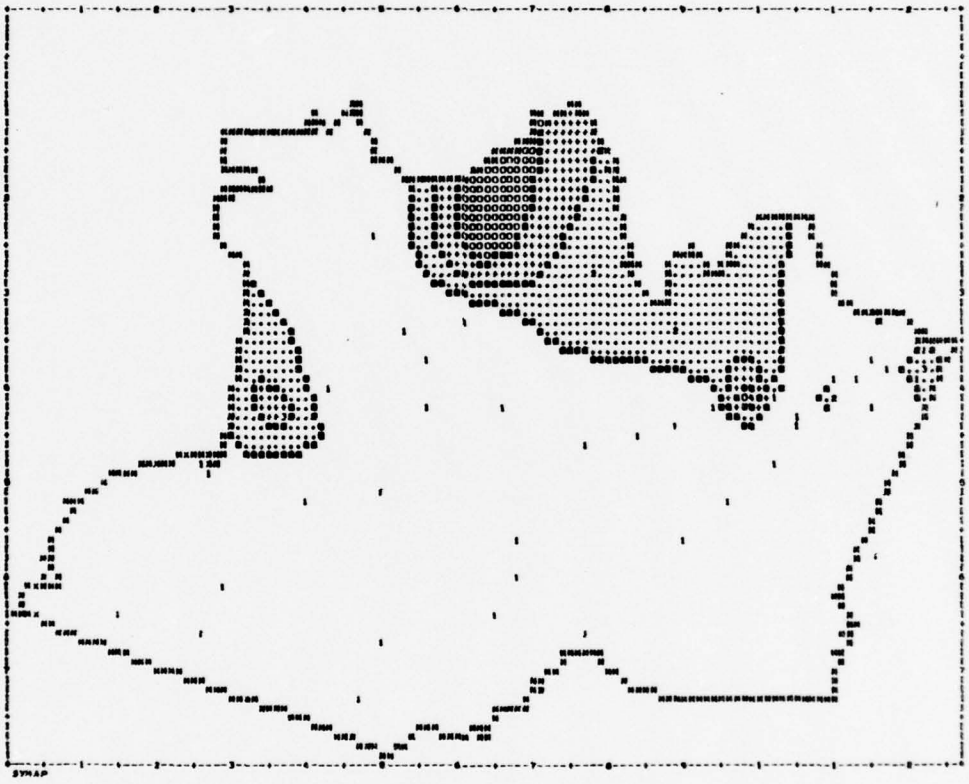
KEY TO PERCENTAGE LEVELS

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	5.00	10.00	15.00	25.00
MAXIMUM	5.00	10.00	15.00	25.00	30.00
LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5

MAP VI

AMAZONAS: PERCENTAGE OF ECONOMICALLY ACTIVE PERSONS, AGE TEN AND OVER, EMPLOYED IN INDUSTRY--1960.



Scale: Approximately 1:14.5 million.

KEY TO PERCENTAGE LEVELS

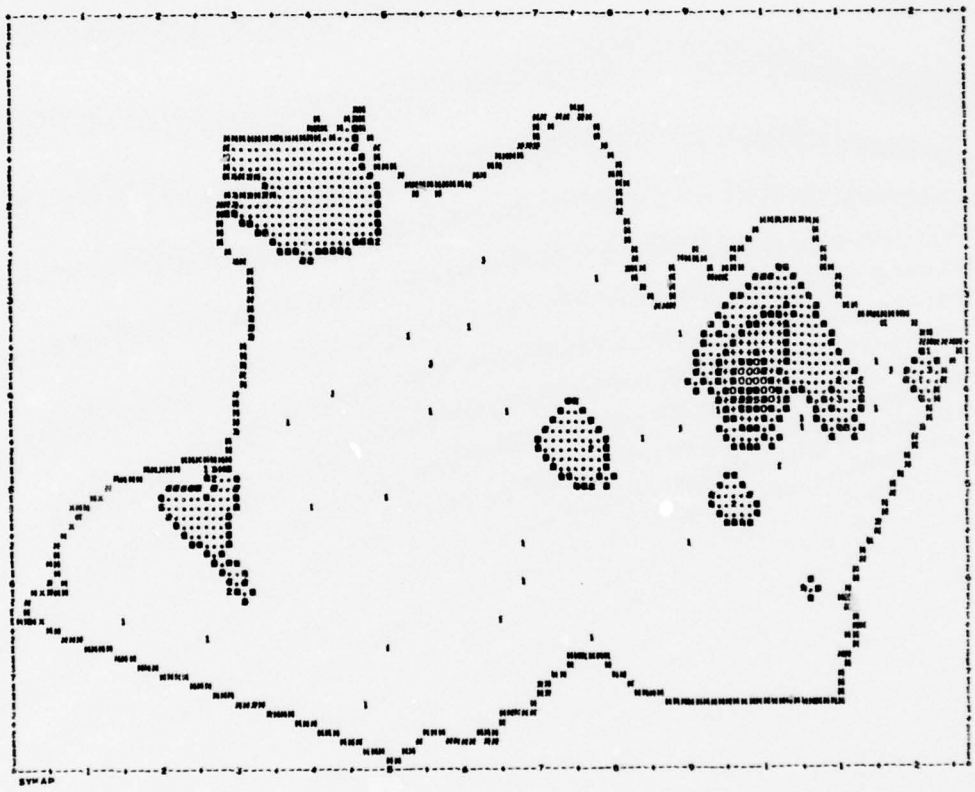
ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	5.00	10.00	15.00	25.00
MAXIMUM	5.00	10.00	15.00	25.00	30.00

LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5

MAP VII

AMAZONAS: PERCENTAGE OF ECONOMICALLY ACTIVE PERSONS, AGE TEN AND OVER, EMPLOYED IN INDUSTRY--1970.



Scale: Approximately 1:14.5 million.

KEY TO PERCENTAGE LEVELS

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	5.00	10.00	15.00	25.00
MAXIMUM	5.00	10.00	15.00	25.00	30.00

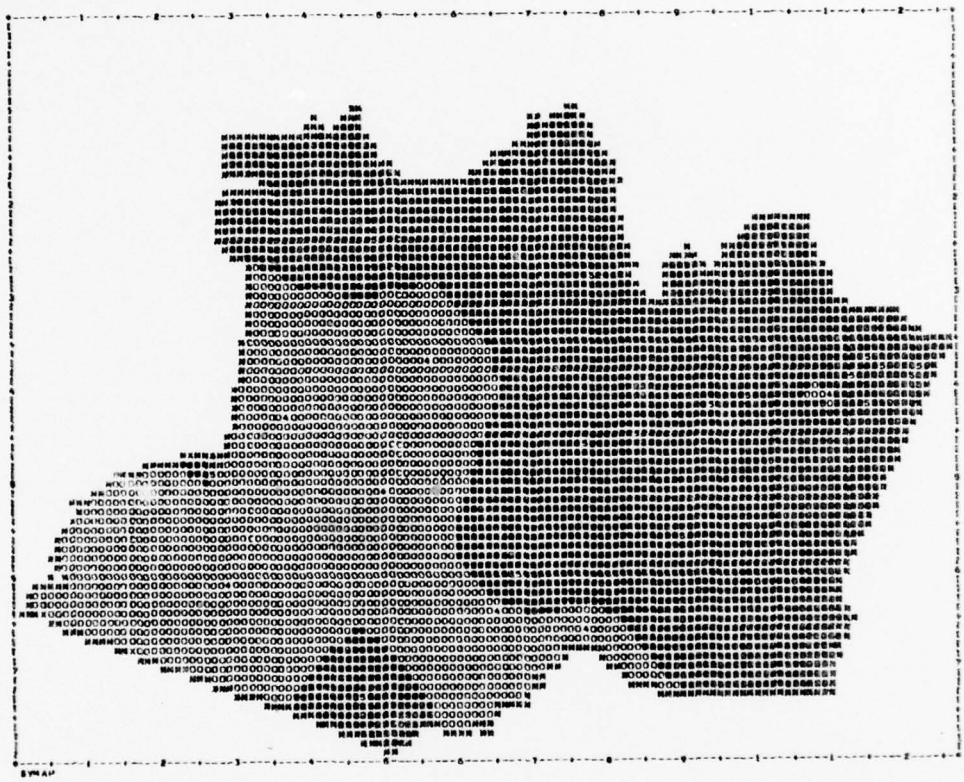
LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5

MAP VIII

AMAZONAS: PERCENTAGE OF PERSONS

THAT ARE ECONOMICALLY ACTIVE--

1950.



Scale: Approximately 1:14.5 million.

KEY TO PERCENTAGE LEVELS

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	30.00	40.00	50.00	60.00
MAXIMUM	30.00	40.00	50.00	60.00	70.00

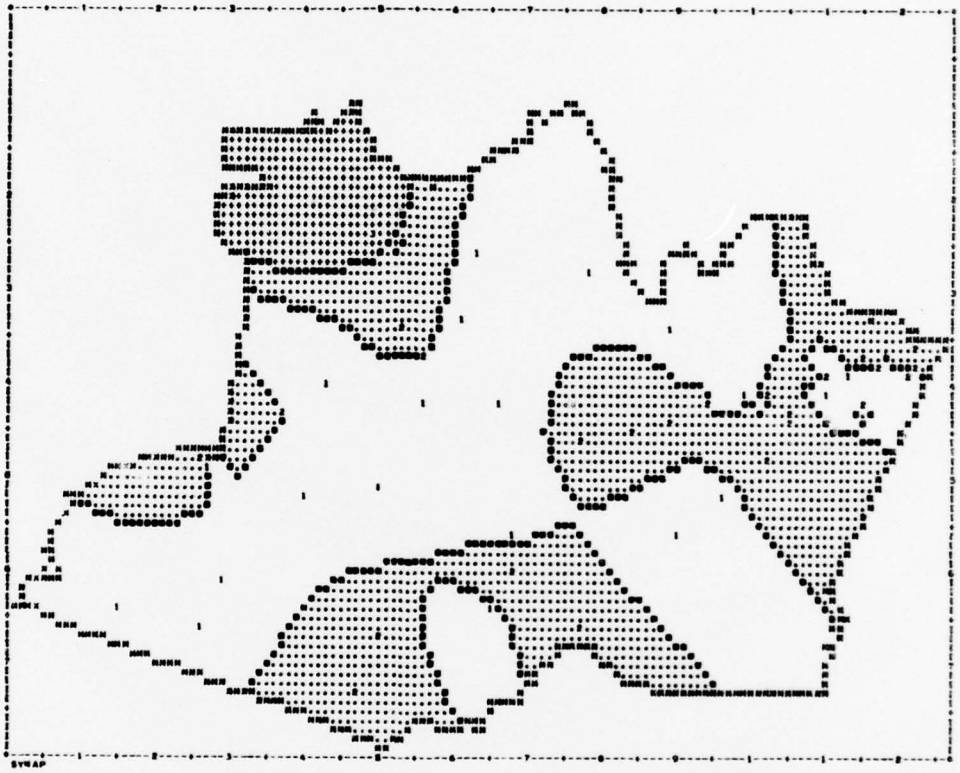
LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5

MAP IX

AMAZONAS: PERCENTAGE OF PERSONS

THAT ARE ECONOMICALLY ACTIVE--

1960.



Scale: Approximately 1:14.5 million.

KEY TO PERCENTAGE LEVELS

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

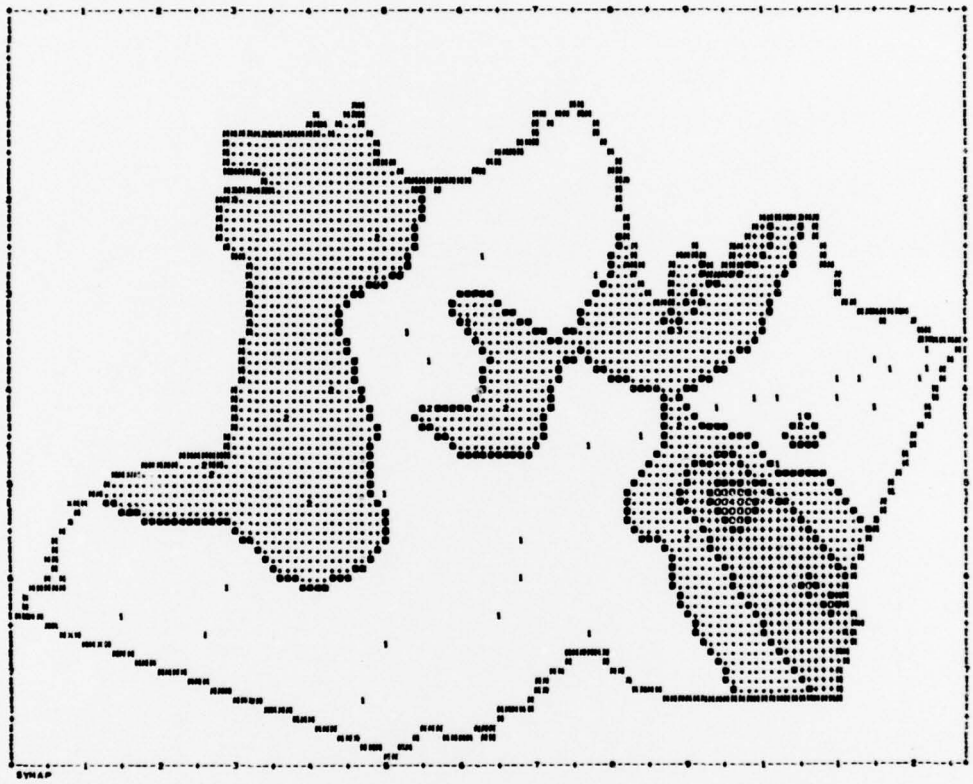
MINIMUM	0.0	30.00	40.00	50.00	60.00
MAXIMUM	30.00	40.00	50.00	50.00	70.00
LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5

MAP X

AMAZONAS: PERCENTAGE OF PERSONS

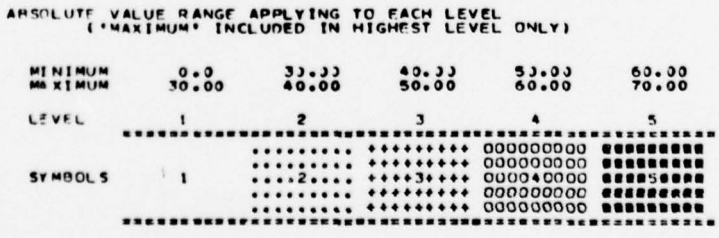
THAT ARE ECONOMICALLY ACTIVE--

1970.



Scale: Approximately 1:14.5 million.

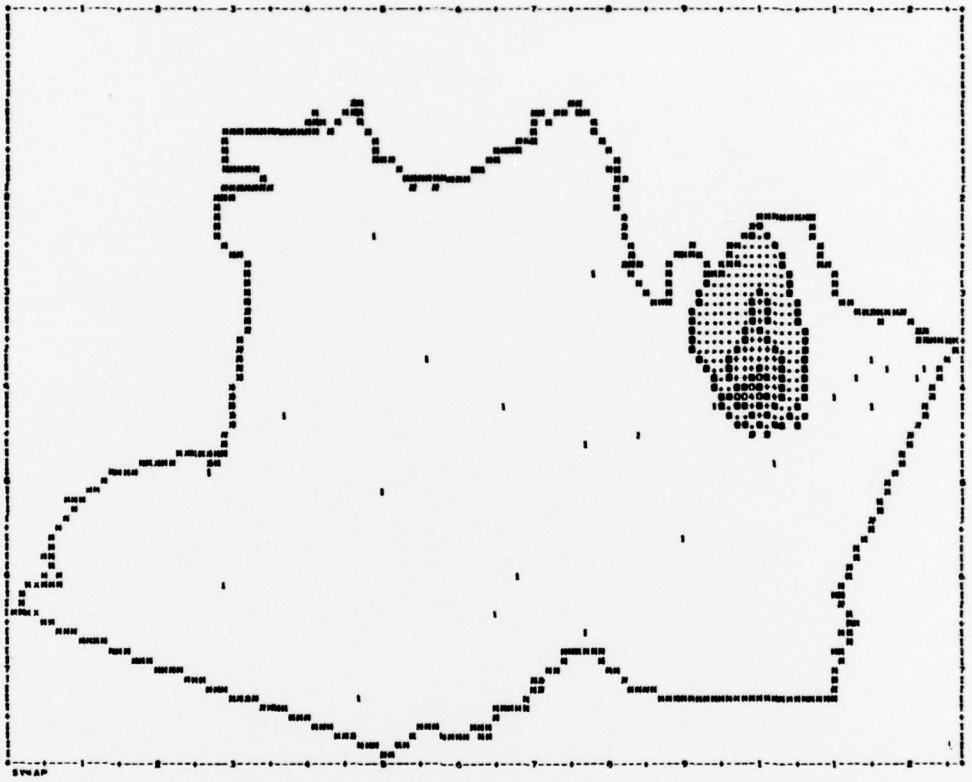
KEY TO PERCENTAGE LEVELS



MAP XI

AMAZONAS: PERCENTAGE OF RESIDENCES

WITH PLUMBING FACILITIES--1950.



Scale: Approximately 1:14.5 million.

KEY TO PERCENTAGE LEVELS

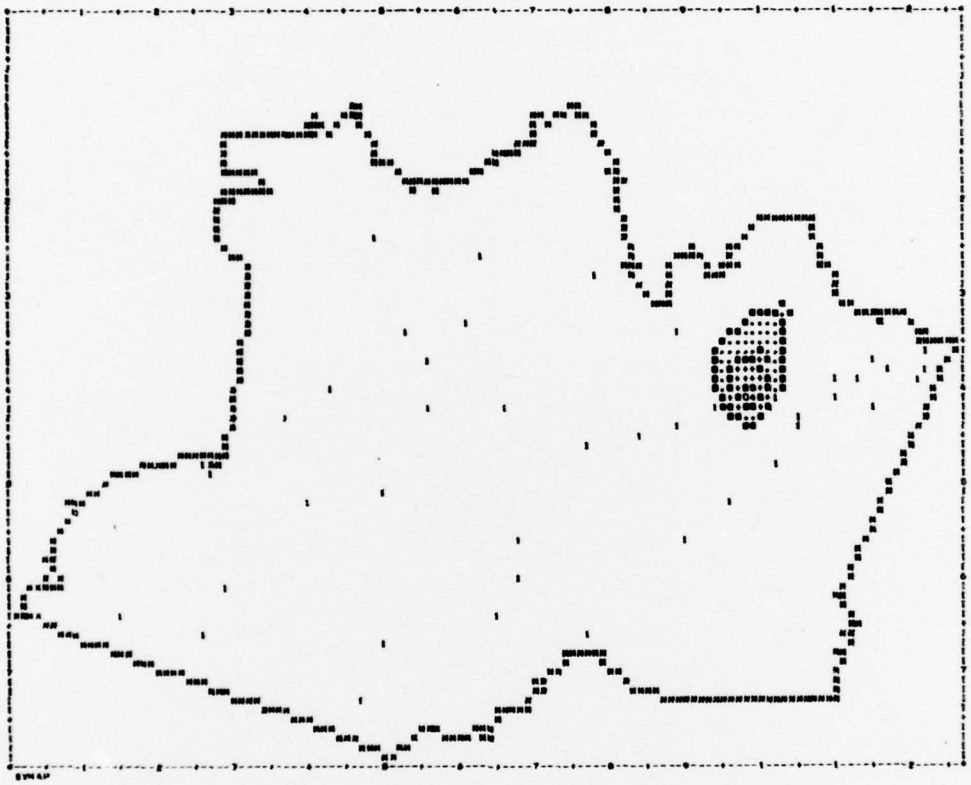
ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	3.0	10.00	20.00	30.00	40.00
MAXIMUM	10.00	20.00	30.00	40.00	55.00
LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5

MAP XII

AMAZONAS: PERCENTAGE OF RESIDENCES

WITH PLUMBING FACILITIES--1960.



Scale: Approximately 1:14.5 million.

KEY TO PERCENTAGE LEVELS

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

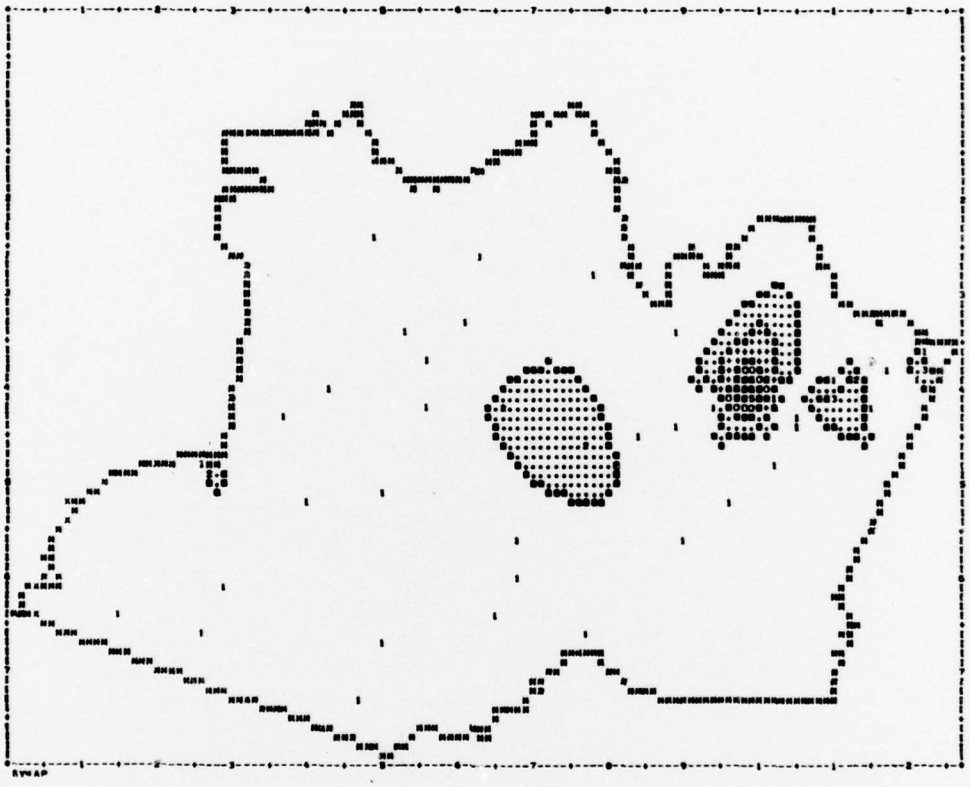
MINIMUM	0.0	10.00	20.00	30.00	40.00
MAXIMUM	10.00	20.00	30.00	40.00	55.00

LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5

MAP XIII

AMAZONAS: PERCENTAGE OF RESIDENCES

WITH PLUMBING FACILITIES--1970.



Scale: Approximately 1:14.5 million.

KEY TO PERCENTAGE LEVELS

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	10.00	20.00	30.00	40.00
MAXIMUM	10.00	20.00	30.00	40.00	55.00

LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5

MAP XIV

AMAZONAS: PERCENTAGE OF RESIDENCES

WITH ELECTRIC LIGHTS--1950.

Scale: Approximately 1:14.5 million.

KEY TO PERCENTAGE LEVELS

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

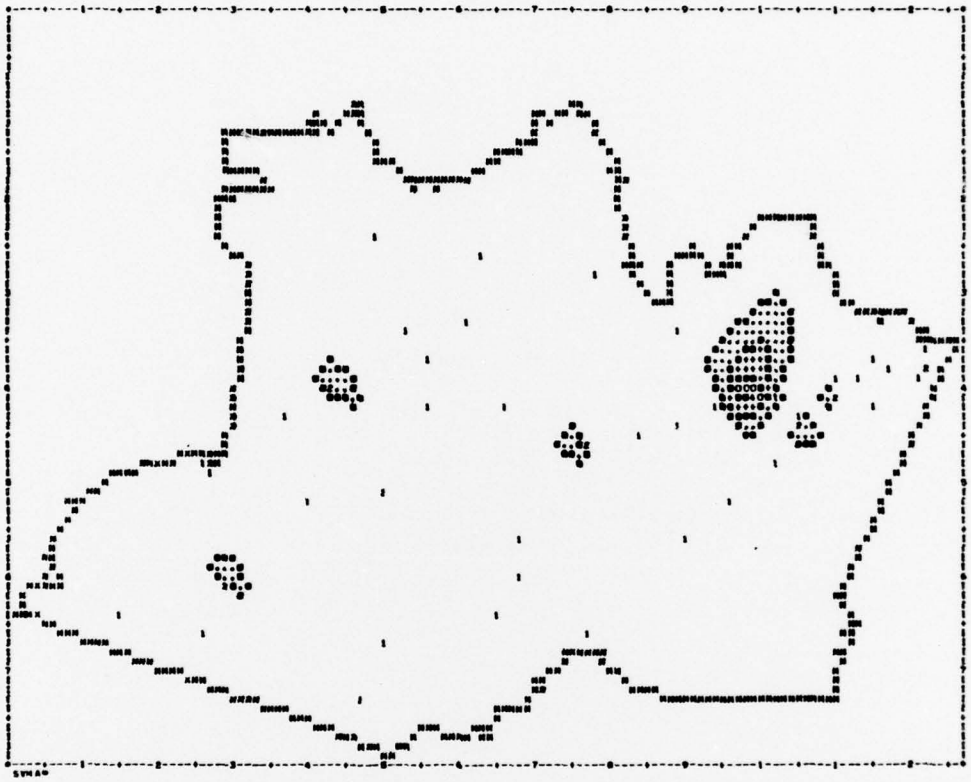
MINIMUM	0.0	10.00	20.00	30.00	40.00
MAXIMUM	10.00	20.00	30.00	40.00	70.00

LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5

MAP XV

AMAZONAS: PERCENTAGE OF RESIDENCES

WITH ELECTRIC LIGHTS--1960.



Scale: Approximately 1:14.5 million.

KEY TO PERCENTAGE LEVELS

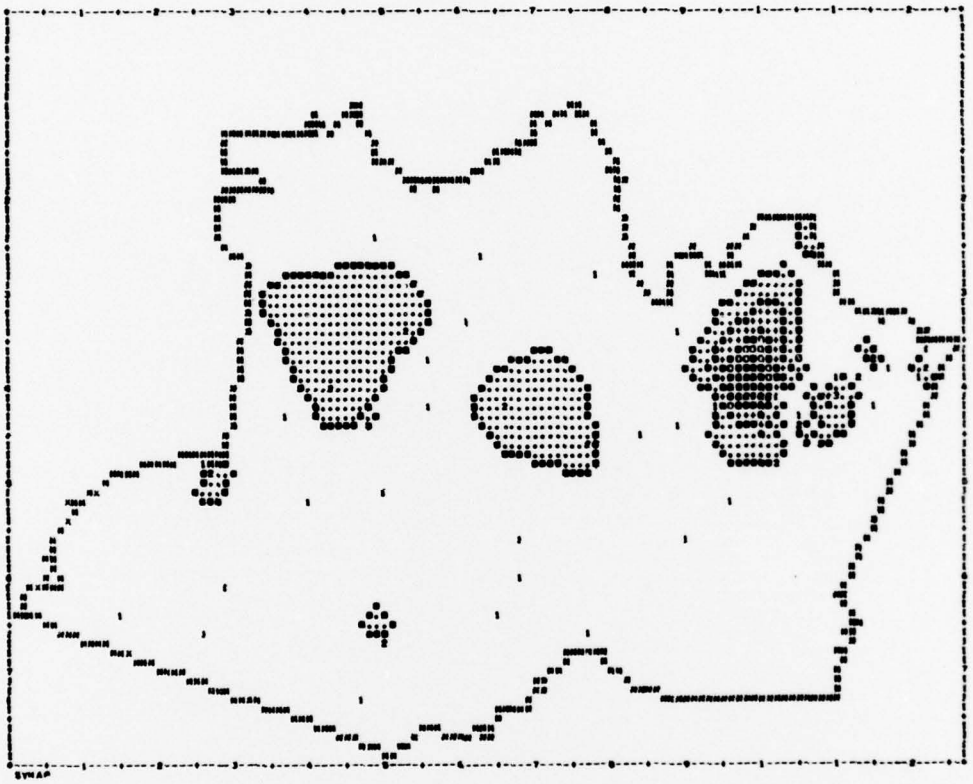
ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	10.00	20.00	30.00	40.00
MAXIMUM	10.00	20.00	30.00	40.00	70.00
LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5

MAP XVI

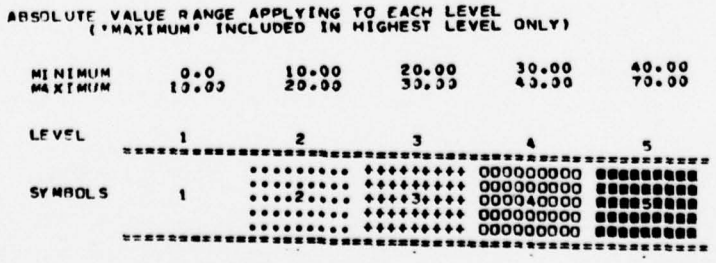
AMAZONAS: PERCENTAGE OF RESIDENCES

WITH ELECTRIC LIGHTS--1970.



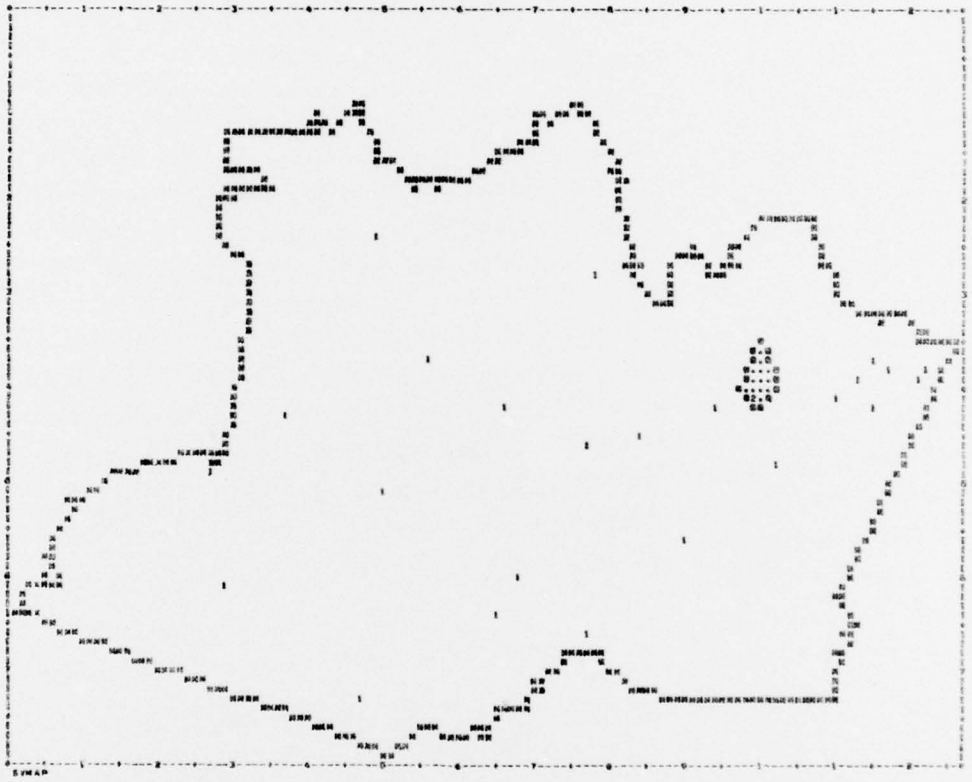
Scale: Approximately 1:14.5 million.

KEY TO PERCENTAGE LEVELS



MAP XVII

AMAZONAS: PERCENTAGE OF PERSONS, AGE FIVE AND OVER, WHO HAVE COMPLETED TWELVE YEARS OF SCHOOLING--1950.



Scale: Approximately 1:14.5 million.

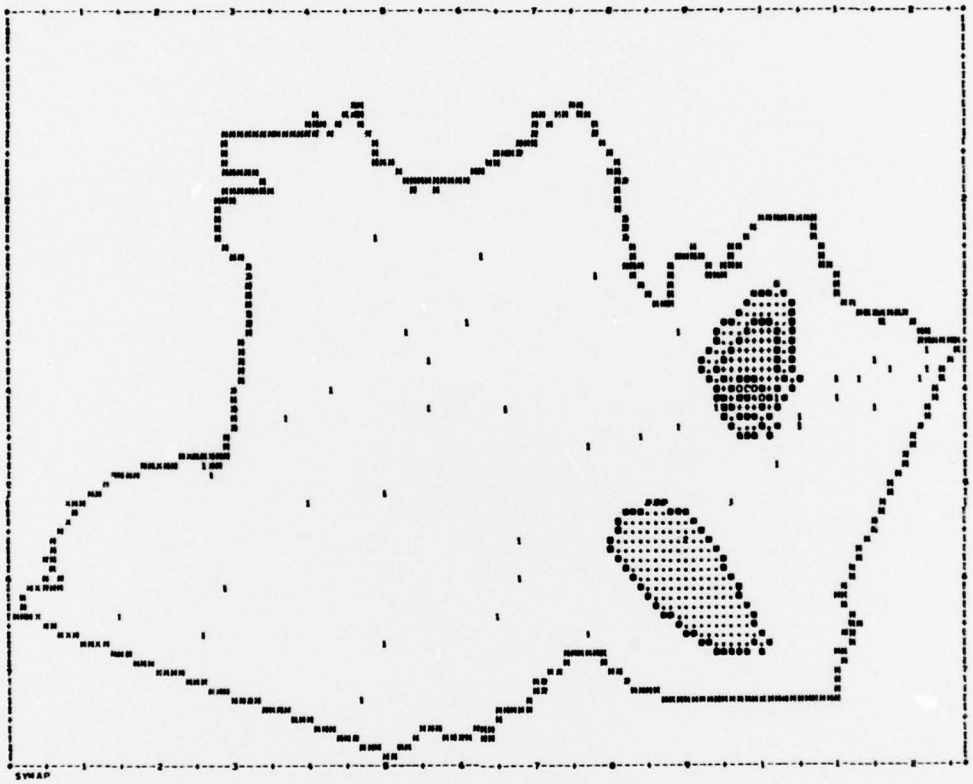
KEY TO PERCENTAGE LEVELS

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.50	1.00	2.00	4.00
MAXIMUM	0.50	1.00	2.00	4.00	5.00
LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5

MAP XVIII

AMAZONAS: PERCENTAGE OF PERSONS, AGE FIVE AND OVER, WHO HAVE COMPLETED TWELVE YEARS OF SCHOOLING--1960.



Scale: Approximately 1:14.5 million.

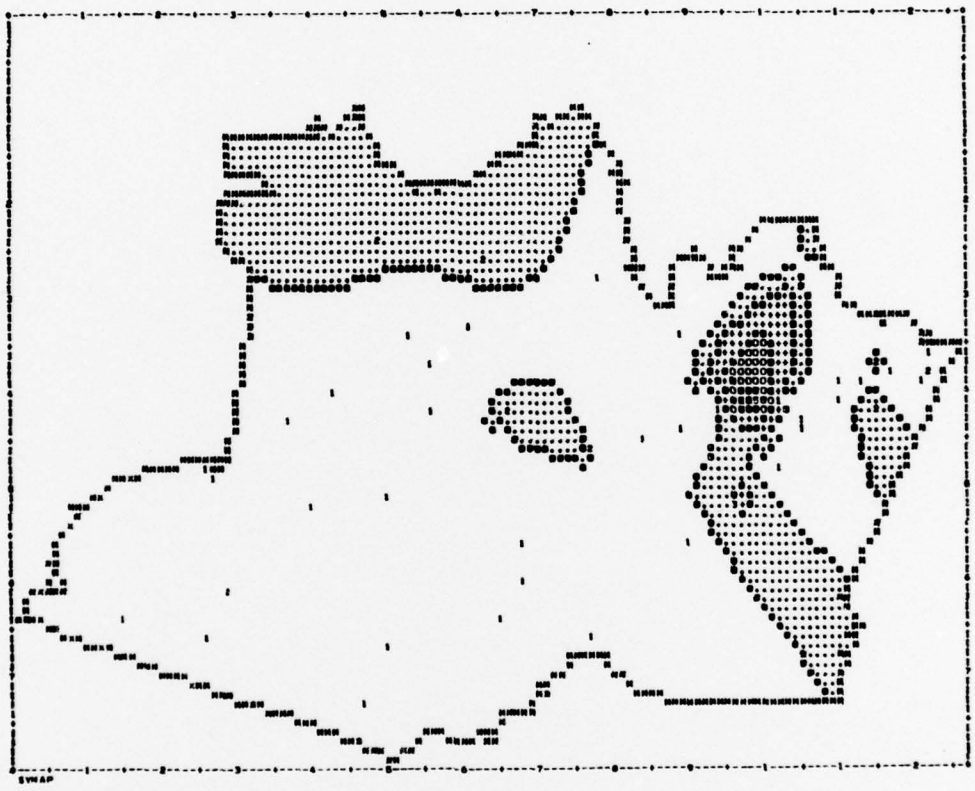
KEY TO PERCENTAGE LEVELS

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.50	1.00	2.00	4.00
MAXIMUM	0.50	1.00	2.00	4.00	5.00
LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5

MAP XIX

AMAZONAS: PERCENTAGE OF PERSONS, AGE FIVE AND OVER, WHO HAVE COMPLETED TWELVE YEARS OF SCHOOLING--1970.



Scale: Approximately 1:14.5 million.

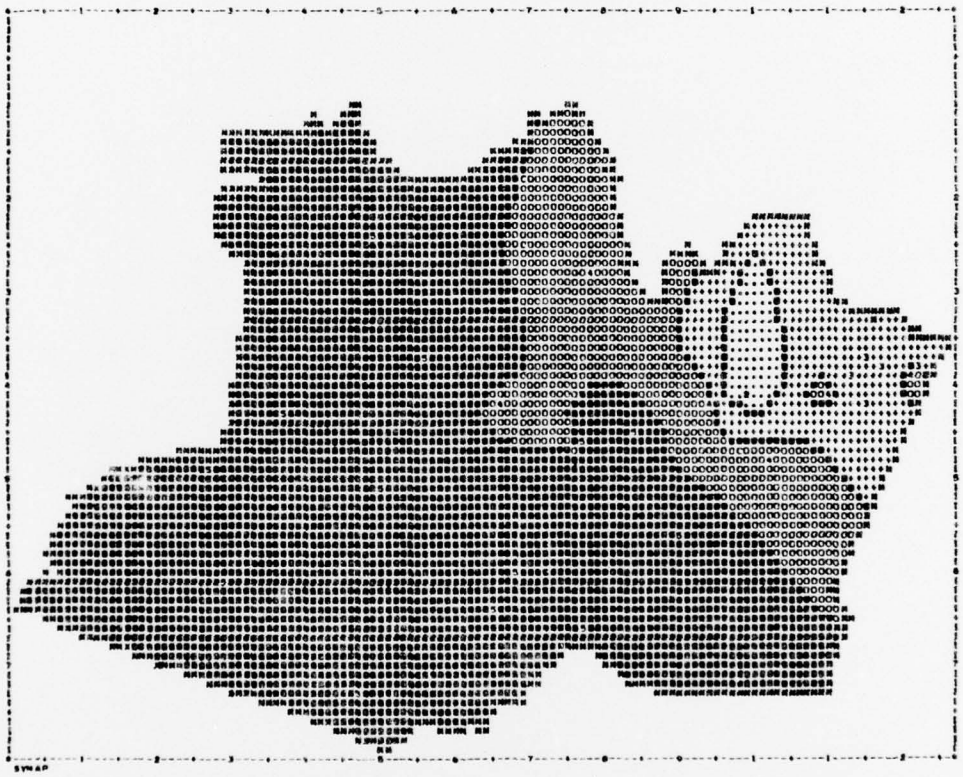
KEY TO PERCENTAGE LEVELS

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.50	1.00	2.00	4.00
MAXIMUM	0.50	1.00	2.00	4.00	5.00
LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5

MAP XX

AMAZONAS: PERCENTAGE OF PERSONS, AGE FIVE AND OVER, WHO HAVE NOT ATTENDED SCHOOL--1950.



Scale: Approximately 1:14.5 million.

KEY TO PERCENTAGE LEVELS

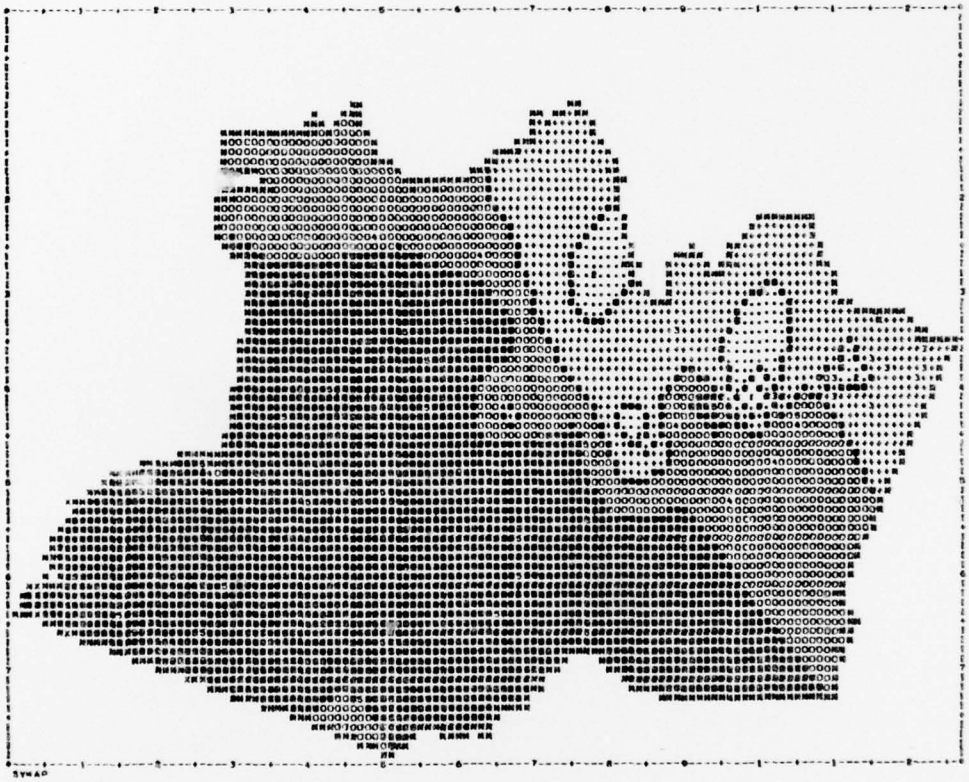
ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	10.00	40.00	50.00	60.00	70.00
MAXIMUM	40.00	50.00	60.00	70.00	100.00

LEVEL	1	2	3	4	5
SYMBOLS	1	.....2.....	+++++3+++++	0000040000	5

MAP XXI

AMAZONAS: PERCENTAGE OF PERSONS, AGE FIVE AND OVER, WHO HAVE NOT ATTENDED SCHOOL--1960.



Scale: Approximately 1:14.5 million.

KEY TO PERCENTAGE LEVELS

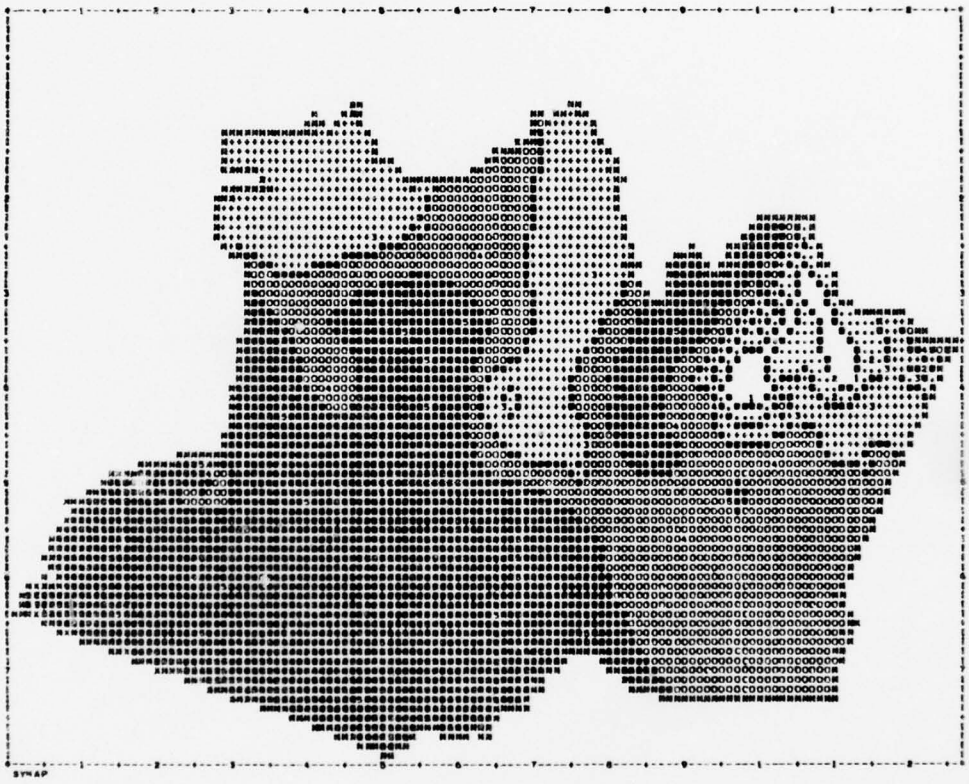
ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	10.00	40.00	50.00	60.00	70.00
MAXIMUM	40.00	50.00	60.00	70.00	100.00

LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5

MAP XXII

AMAZONAS: PERCENTAGE OF PERSONS, AGE FIVE AND OVER, WHO HAVE NOT ATTENDED SCHOOL--1970.



Scale: Approximately 1:14.5 million.

KEY TO PERCENTAGE LEVELS

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	10.00	40.00	50.00	60.00	70.00
MAXIMUM	40.00	50.00	60.00	70.00	100.00

LEVEL	1	2	3	4	5
SYMBOLS	1	2	3	4	5